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SNOWMOBILES AS UTILITY VEHICLES IN THE ARCTIC: CURRENT PERFORMANCE AND PROSPECTS FOR IMPROVEMENT.

Final Report

Dr. P.J. Poole

May 1982

The contents of this report reflect the views of the contractor and are not necessarily the official views or policies of the Transportation Development Centre.

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17. Abstract

A research study precipitated by reports of escalating costs of snowmobile acquisition and operation in the Canadian Arctic, accompanied by decreasing utility as working machines. The objective was to estimate the prospects for developing a more suitable machine for Inuit use. Historical surveys revealed, declining sales, fewer manufacturers and models, and a convergence in design since 1970 - with present sales about 25% of that peak year. The Inuit market is only 1% of the total but is comparatively stable. Technical research indicated that accumulated engineering knowledge is sufficient to design a suitable utility machine but such a model would be unlikely to appeal to the mass of recreational users. Moreover, current commitments to large volume production prohibit small-volume specialised manufacture at reasonable cost. As an example, a general description was given of a utility machine with the emphasis upon pulling power and durability and a simplicity of construction based upon a modular approach to design and assembly. It was concluded that the economic/design problems posed by present methods of mass production might be circumvented by evolving a production/assembly process viable for local, small-scale manufacture. An investigation into the feasibility of such a course of action was recommended as a follow-up to this study. It was further suggested that this be undertaken as a collaboration between a team of engineers and representative Inuit organisations.

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17. Résumé

Cette étude fait suite à l'observation du coût croissant et de l'utilité décroissante des motoneiges utilisées dans l'Arctique. On a voulu évaluer les possibilités de production d'un véhicule mieux adapté aux besoins des Inuits. Une revue du marché de la motoneige indique une décroissance des ventes ainsi qu'une réduction des modèles disponibles et des manufacturiers: les ventes sont présentement à 25% du niveau de 1970. Le marché Inuit n'en représente que 1% mais demeure stable. L'étude démontre que l'expertise existe pour la conception d'une motoneige arctique, mais que ce véhicule utilitaire ne pourrait plaire à la majorité des utilisateurs sportifs. De plus, les impératifs industriels ne permettraient pas la production à un prix raisonnable d'un véhicule à diffusion restreinte. Pour illustration le rapport définit les spécifications générales d'une motoneige utilitaire fondées sur une construction modulaire, en mettant l'accent sur la capacité de traction, la durabilité et la simplicité.

Afin de contourner le dilemme quantité/coût il est proposé d'étudier un procédé d'assemblage faisant appel à la main-d'oeuvre Inuit. Ceci ferait l'objet d'une étude de faisabilité en collaboration avec des associations Inuits.

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FOREWORD

The issue of escalating costs of snowmobile acquisition and operation in the Canadian Arctic, without concommittant improvements in utility performance, was bought to light in the course of investigations by the Inuit Development Corporation into the prospects for expanding intersettlement trade between Inuit communities. The snowmobile/sled combination was one means of transport considered for this purpose.

Officials from the Arctic Transportation Directorate and the Transportation Development Centre expressed an interest in the work of the Inuit Development Corporation. The Transportation Development Centre responding to the "snowmobile problem" by sponsoring a project to investigate ways of resolving this issue. The Inuit Development Corporation was represented on the inter-departmental committee which reviewed progress on the project and. in addition, provided active assistance and encouragement while it was in progress.

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SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The design and production of snowmobiles is certainly dominated by the need to serve the recreational market, but a long-term, and continuing decline in that market is obliging manufacturers to pay more attention to the requirements of the very small but comparatively stable Arctic utility market.

2. This market is now being served by modifying certain recreational models and presenting them as "dual-purpose" machines. Thus, the potential for responding to utility requirements is limited by the scope these recreational models provide for modification.

3. The modifications undertaken by manufacturers are limited in that sense and also by the economics of production: how to produce small volume models or features at acceptable prices.

4. The methods by which snowmobiles are now produced prohibit the possibility of designing and manufacturing an entirely new utility snowmobile. For such purposes, users must rely upon two utility models that have been in production for over ten years.

5. The developments and changes that have occurred in the course of refining snowmobiles for recreational use have not always been disadvantageous for utility use, but, it appears that certain avenues of research which could have improved utility performance may have been inevitably passed by in favour of those with more promise for recreational performance.

6. The dual-purpose models recently introduced are providing improved utility performance, but not at lower cost. In fact, the continuing escalation in costs of aquisition and operation is likely to become the dominant factor in selecting future snowmobiles.

7. There may be scope for the small-scale production of a mid-size utility snowmobile if this were done by a simplified modular process of assembly. Such a machine might follow early snowmobiles in basic concept but would take advantage of improved technology and materials. It would not possess the speed or styling typical of current models.

Recommendations

1. If Conclusion No. 7 is to be acted on, the first step should be a study of its practical and economic feasibility and a comparison of the results with the production economics of present manufacturers.

2. This first step in a possible R&D program should only be undertaken if an Inuit or other organisation with a committed interest in the further development of the high Arctic assumes responsibility for coordinating such a program and acting at the interface between technologists and Inuit users.

1. INTRODUCTION

> Over the past years the different manufacturers have invested untold moneys developing stable, fast, comfortable snowmobiles. Weight has always been a factor in gaining the final results. The lighter the final production unit is, the faster it eats up the trails, manoeuver turns and moguls and result in an overall more comfortable riding machine.
> The original production machines that most of us cut our teeth on could be described as nothing more than anchors. They were assembled with heavy materials for a good reason - the type of terrain the sleds were called upon to cover. As much as we hate to admit it, before the trails systems became as expansive as they are today, the open fields, lakes and yes, even paved roads were the main snowmobile trails. . . .
> In order to stand up to this type of punishment, the sleds were over-built. Today, what might be a thin aluminium bracket, had to be made of steel plate 15 years ago.
>
> "Snowmobile Canada", 1982, 13(2):42-43.
> (emphasis added)

The sentiments expressed in this quotation, and the snowmobile design changes they reflect, have precipitated the study described in this report. Fifteen to twenty years ago, the "anchors" were the mainstay of the snowmobile market. But this market was limited to those who required snowmobiles as working or utility machines. But the demand for utility machines was soon overtaken by an escalating demand for snowmobiles as recreational machines and, once the basic design configuration became established, further technical evolution was dominated by the requirements for accomplishing well-organised travel along well-groomed trails with style, speed, comfort and safety. In the course of this design evolution, the requirements for snowmobiles as utility machines were largely neglected and, until very recently, the only advertised working machines on the market were two survivals from the era of the "anchors".

The unsuitability of recreational snowmobiles when put to working uses has been demonstrated most emphatically in the tundra regions north of the tree-line. In these extreme operating environments, snowmobiles are subjected to more demanding uses by Inuit, in the course of hunting, trapping and fishing, than by any other group of users. In the late 1970's the Board of Directors of the Fédération des Coopératives du Nouveau Québec formally requested one manufacturer to reintroduce a model which had acquired a good reputation as a working machine but which had been withdrawn from the production. The inadequacies of currently available models were repeatedly brought to the attention of staff of the Inuit Development Corporation engaged in programs of renewable resource development. They were also noted at a, 1978, meeting of the Science and Technology Committee of the Advisory Committee on Northern Development, when the Chairman of the Northwest Territories Science Advisory Board, Dr. O. Solandt, observed that "A better and more rugged skidoo is needed that is not a recreational type and sells for half the current price" (Eggleton 1978). This remark summarises the two principle dimensions of the 'snowmobile problem': (1) the question of machine design and construction, (2) the problem of rising costs for initial purchase and spare parts - exacerbated by escalating costs for fuel. This observation also begs the question of whether both problems can be resolved simultaneously; this question is the central economic issue addressed by this study.

1.1. STUDY OBJECTIVES

The Overall Objective contained in the Work Statement for this project is the "Development of a vehicle for light transportation tasks in the Arctic having an improved performance compared with present snowmobiles."

"The project is being undertaken by the Transportation Development Centre (TDC) of Transport Canada in collaboration with the Arctic Transportation Directorate (DGRT) to obtain a detailed understanding of the problem and evaluate the feasibility of an R&D program to improve snowmobile performance" (TDC 1981).

At first glance, it would appear that the overall objective stated above might be attained in one of three ways:

1. By determining snowmobile improvements that may readily be made to existing models without radical changes in production procedures. These would be design changes which would not increase production costs to the point where market research would be required to support their adoption.
2. By determining major improvements, which would require significant changes in tooling and production economics and in turn require confidence on the part of the manufacturer that the market would bear the eventual increased price to the buyer.
3. By determining that the kind of improvements required cannot be realistically expected to be developed by

> snowmobile manufacturers, given the small size of the Arctic utility market, and could therefore only be provided by a government supported R&D program. This, of course, would not necessarily resolve the question of how the more costly improvements emerging from such a program could be economically incorporated in snowmobile production.

All three statements imply that the problem is one of production engineering as much as design engineering R&D and, in fact, as this study progressed, the question of the economic feasibility of snowmobile improvements emerged as a dominant theme. The manufacturers know how to make more rugged machines; they do not feel that the small utility market will accept the costs.

The suggestion that snowmobiles should be built that are both more rugged and less expensive reflects the view that, by simply discarding those 'recreational features', that have added to costs while actually degrading utility performance, this objective may be brought closer. This may be an understandable reaction to some of the more flashy and costly amongst currently available models; however, it should be remembered that the utility models that have survived from the sixties are not significantly different in price from other models. The case may rather be that snowmobiles have become more expensive for similar reasons that cars and motorcycles have, and that, just as aircraft built and equipped for arctic operation are more expensive than their southern counterparts, so will utility snowmobiles inevitably cost more.

1.2. STUDY AREA AND LIMITATIONS

The study will concentrate upon snowmobile use in Canada north of the tree-line in the Northwest Territories and Québec (Map 1). Thus, the principle focus will be upon light vehicle transport over tundra snow and the landfast ice. However, since many of the inhabitants of communities at or close to the tree-line may regularly travel into the taiga region, this use of snowmobiles amongst trees and in comparatively deep and soft snow will also be taken into consideration in this context.

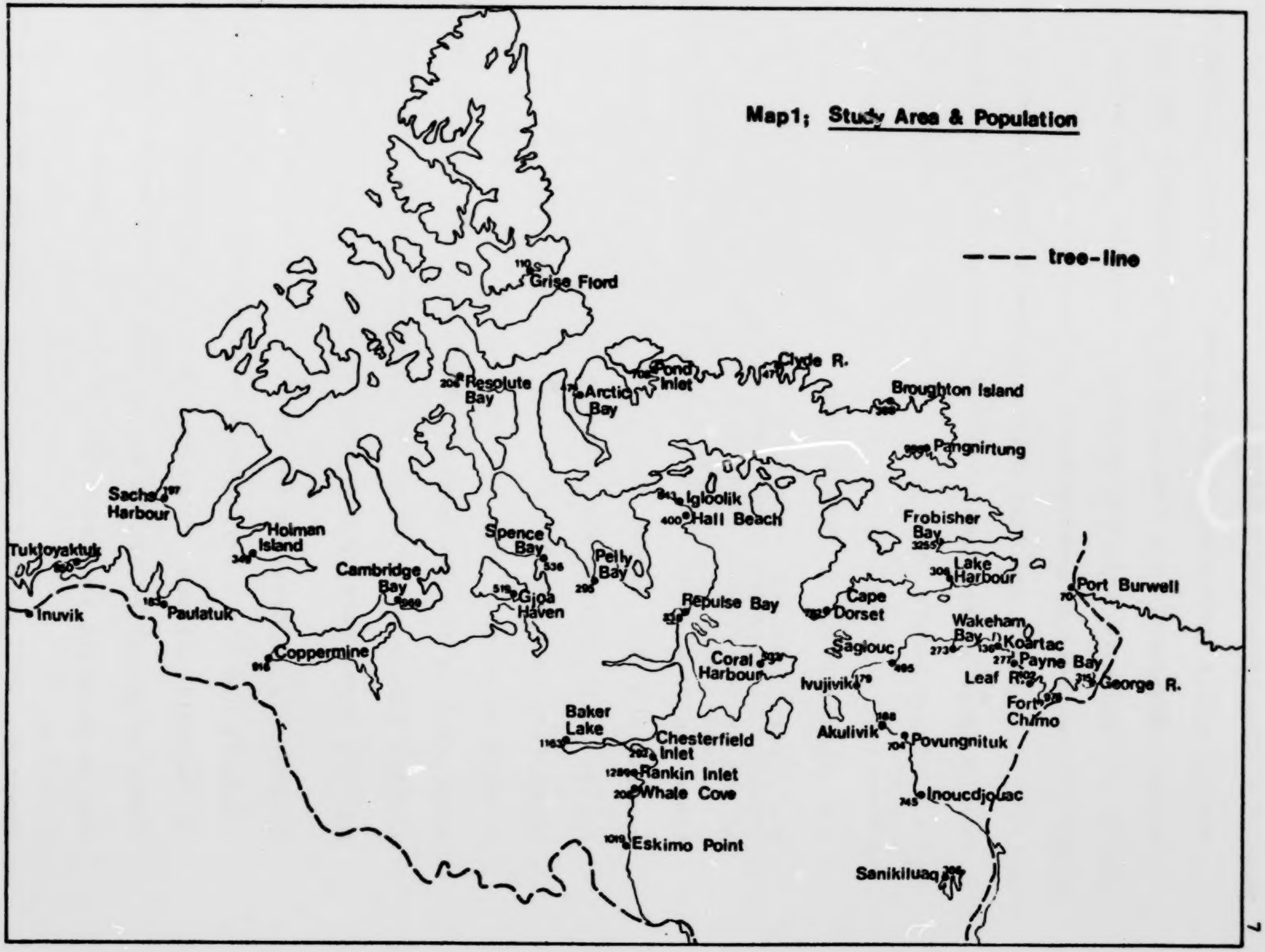
The study will concentrate further upon the use of snowmobiles by Inuit in this region for hunting, trapping, fishing and long-distance travel. With relatively minor exceptions, such as reindeer herding in Tuktoyaktuk, these four activities encompass the range of uses to which snowmobiles are put. Other user groups, for example scientific parties or the armed forces, may also rely upon snowmobiles as working vehicles, but the indications are that such uses do not depart significantly from Inuit use, either in terms of intensity of use or precise type of activity. In fact, the material gathered in this study suggests that what may be called serious or regular use of snowmobiles by Inuit places more demands upon the machinery than any other type of utility use.

1.3. STUDY METHODOLOGY

The study was conducted in three phases:

1. Library research on previous studies on snowmobile performance and records of snowmobile performance maintained by government agencies - including the

Map1; Study Area & Population



Department of Defense.

2. Field interviews with snowmobile dealers, mechanics and users in a number of communities selected to represent variations both in resource harvesting activities and environmental conditions. Communities visited were Fort Chimo, George River, Frobisher Bay, Pond Inlet, Cambridge Bay Yellowknife, Tuktoyaktuk, and Inuvik.

1.4 ORGANISATION OF THIS REPORT

The report commences with an account of the history of the snowmobile industry, both in general and in the Arctic. This will trace the origins of the snowmobile as primarily a utility vehicle and will assess the extent to which, once the basic design configuration was established, the rapid increase in its popularity as a recreational machine contributed to its declining efficiency as a working machine. This account will also consider the development of distribution systems in the Arctic, access to spare parts and repair facilities, and the bearing these have upon snowmobile operation and performance.

Chapter 3 will describe the various forms of Inuit working use, identify how their performance requirements differ from those of recreational use, consider longevity of snowmobiles, the costs of operation in the Arctic and the extent to which these may be expected to rise over the next five years.

Chapter 4 will present the comments, cricisms and opinions by users, mechanics and dealers that were gathered in the course of the field work. These data will be organised with reference to particular clusters of snowmobile components, e.g. power plant and transmission, tracks/skis, etc. For each cluster of components, the factors influencing the evolution of design will be considered as well as the scope for altering the design in response to the comments and criticisms gathered in the field. This chapter will provide a basis for distinguishing between those design changes that have only been beneficial for recreational use and those which have also improved utility performance.

In the final section, the objectives summarised in subsection 1.3 will be considered in the light of the data presented.

2. THE SNOWMOBILE INDUSTRY

Polar Snowmobile, 1961, price: $1,495, specifications: rear mounted 9.5 hp engine, welded 16 and 18 guage steel body, windshield, 2 inch padded seat, brake, electrical system (starter-generator, lights, battery), clutch guard, first-aid kit, snowshoe rack, compass. Weight: 660 lbs. Estimated price in 1981: United States dollars, $3-4,000.

Snowmobile Industry & Sport
Newsletter
March/April 1981, p. 19.

2.1. INTRODUCTION

This chapter commences with an historical account of the changes that have taken place in the snowmobile industry since its beginnings in the 1960's. This account illustrates how dramatic sales increases in the recreational market led manufacturers to evolve designs which responded to the demand from that sector. Such design development was not inevitably antithetical to the needs for Arctic utility machines, but any benefits this market derived from that evolution were largely incidental.

By examining the past relationship between the Arctic utility market and the southern recreational market, this chapter will attempt to determine the extent to which the Arctic utility sector is dependent upon the recreational sector. This will provide a background for evaluating the influence that current trends will exert upon the future development of utility machines.

The first of the following sections will review progress since the 1960's and will review the general merits of current snowmobiles models as utility machines. The second will review the organisation of the snowmobile industry north of the tree-line and discuss the efforts that have been made by manufacturers to produce a machine suitable for use in that region.

2.2. THE SNOWMOBILE INDUSTRY: 1960's TO THE PRESENT

Four significant trends appear during this period: (1) a dramatic increase and then slower decline in snowmobile sales; (2) a gradual decrease in the number of snowmobile manufacturers and number of machines produced; (3) a trend towards uniformity in the design of snowmobiles, and (4) an increase in Japanese participation in the industry.

2.2.1. Snowmobile sales since the 1960's: Canada and the United States

Table 1 has been produced from data provided by the International Snowmobile Industry Association (ISIA). It seems that comprehensive sales records were not maintained before 1964 and those between 1964 and 1967 were subjected to some degree of extrapolation. However, they are detailed enough to illustrate the magnitude of the 200% increase in total sales that occurred during the 1968/69 season, an increase which continued, though less dramatically, until 1970/71. High sales levels, approaching 500,000 units a year persisted until 1972/73, after which they suffered a 29% decline, a trend which continued until sales feel below 200,000 units in 1976/77. Sales

Table 1: RECORD OF SNOWMOBILE SALES IN THE UNITED STATES, CANADA, ALASKA, YUKON & NORTHWEST TERRITORIES, 1964-1982

Year	Total Sales	United States	Canada	Alaska	Yukon & NWT	Alaska Yukon & NWT
until 1964	35,000	23,870	11,130	478	56	534
64/65	40,000	27,280	12,720	546	140	686
65/66	55,000	37,510	17,490	751	297	1,048
66/67	70,000	47,740	22,260	956	512	1,468
67/68	85,016	58,095	26,921	1,164	790	1,954
68/69	255,051	174,286	80,765	3,491	2,370	5,861
69/70	423,427	296,604	126,823	4,927	2,999	7,926
70/71	493,662	342,035	151,627	4,829	2,683	7,512
71/72	458,162	332,177	125,985	4,735	1,715	6,450
72/73	449,570	316,036	133,534	4,956	836	5,792
73/74	443,044	290,624	144,420	6,660	1,051	7,711
74/75	316,014	192,185	123,829	4,031	527	4,558
75/76	242,043	153,902	88,741	4,391	435	4,826
76/77	194,887	111,489	83,398	4,034	2,081	6,115
77/78	226,035	140,550	85,484	4,638	2,403	7,041
78/79	260,154	174,644	85,510	4,653	1,718	6,371
79/80	189,826	127,175	82,651	4,103	1,764	5,867
80/81	166,168	99,047	67,121	3,904	1,995	5,899
81/82	(147,000) est.	N/A	N/A	N/A	N/A	N/A

recovered slightly over the next two seasons, though they barely passed the 250,000 level; they then declined to levels below those which preceded the enormous surge in 1968/69. The latest (total only) shipment figures received by ISIA (to January 31, 1982) are 120,000. It appears unlikely that this total will exceed 130,000 for 1981/82, a further decline of 22% over the previous season.

Figure 1 illustrates the relationship between Canadian sales and United States sales over this period. This shows that though sales in both countries accelerated at comparable rates during the boom years of 1967 to 1971, subsequent behaviour varied, with the United States' market both exhibiting wider fluctuations than the Canadian market and eventually falling more steeply to constitute a smaller share of the total market than it had held during the peak sales season of 1971/71. During 1970/71 the United States share was 69%, by 1980/81 it had fallen to 59%. With declining sales, a similar change has taken place in the relationship between total sales and those in the Yukon, the Northwest Territories and Alaska. This change is reviewed below.

2.2.2. Snowmobiles shipments since the 1960's: Northwest Territories, Yukon and Alaska

Figure 2 shows the shipment levels since the 1960's. These are again extracted from ISIA records, which give only combined figures for the NWT and the Yukon. It is interesting to note that, while shipments to northern regions shared the enormous

Figure 1

SNOWMOBILE SHIPMENTS, 1964-1981: NORTH AMERICA, UNITED STATES, CANADA

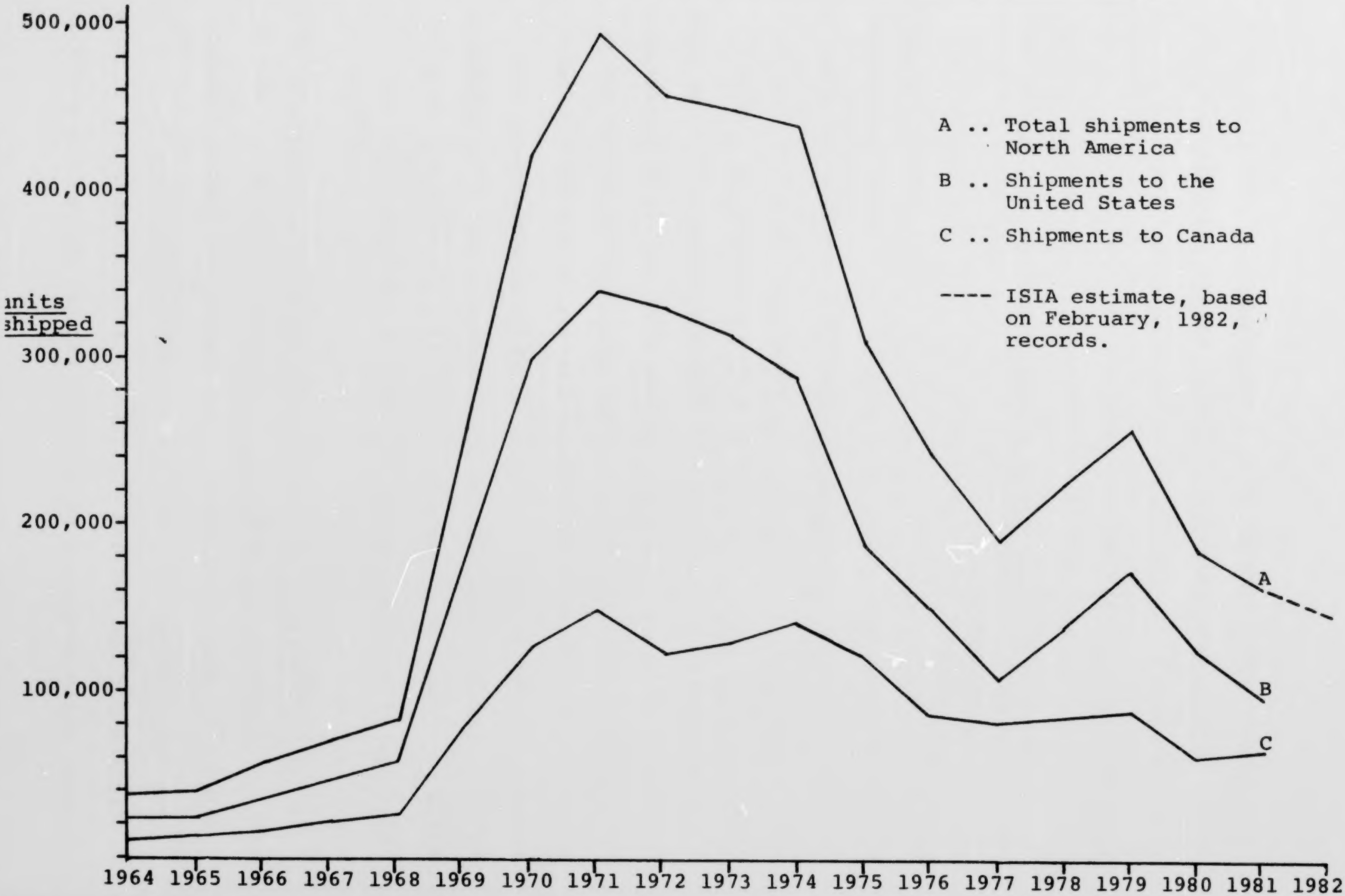
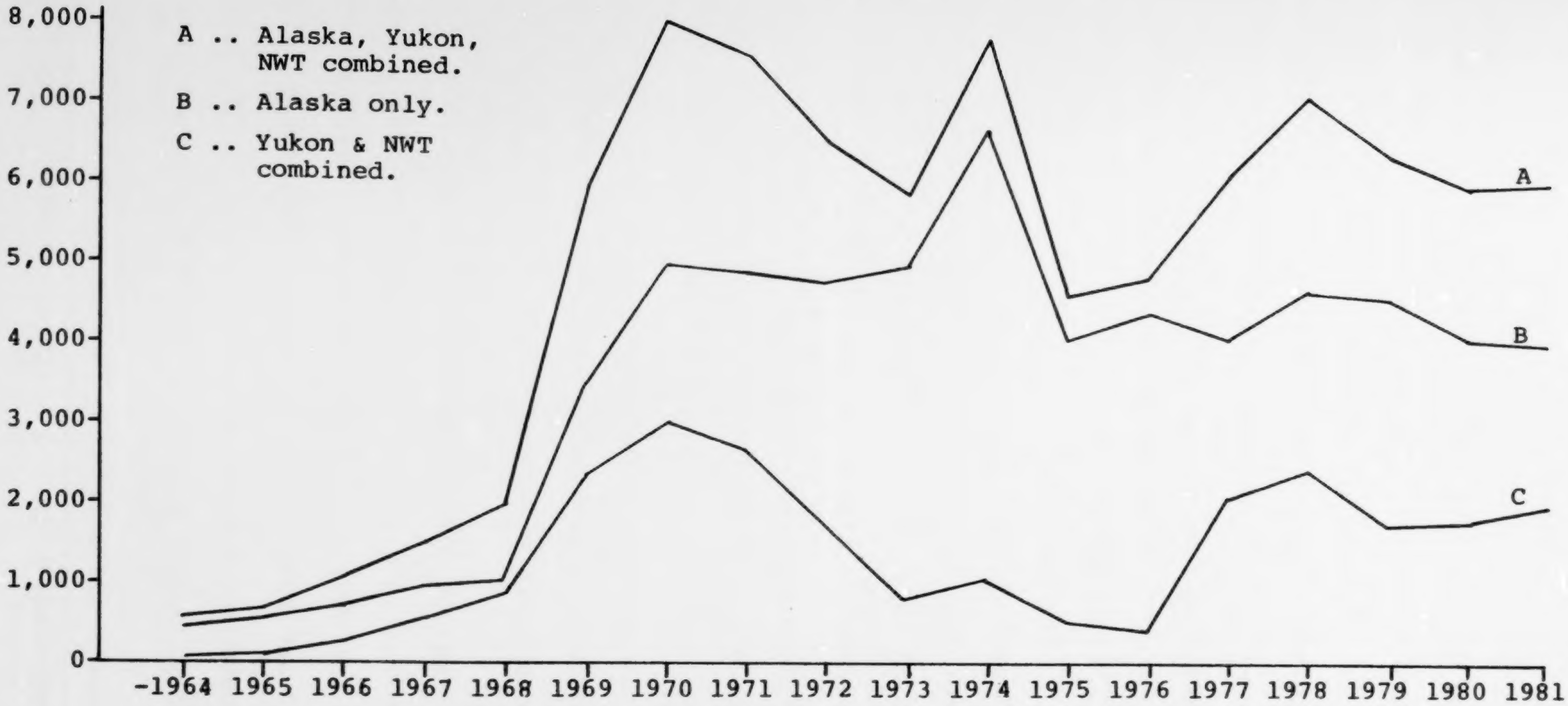


Figure 2

SHIPMENTS OF SNOWMOBILES TO NWT, YUKON, ALASKA, 1964-1981



surge of the late 1960's with those to southern regions, and also the subsidence which followed, the recovery in the late 1970's was stronger and came closer to the levels of the peak years than the recovery in southern markets. Furthermore, the current decline which followed this partial recovery was less dramatic in the north than in the south.

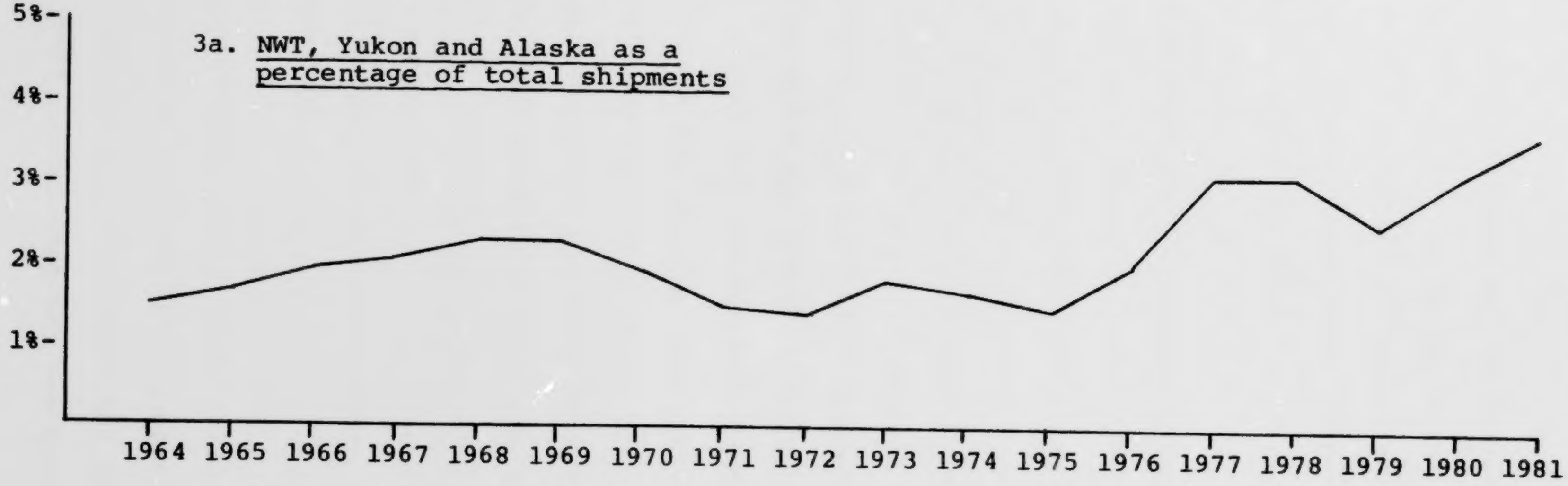
In fact, shipments to the Northwest Territories and the Yukon are shown to be enjoying a second recovery, in contrast to those in Alaska which indicate a slight decline. However, such slight trends in the northern markets should be treated with caution as they reflect variations in only a few hundred machines. A similar slight anomaly is evident in the NWT/Yukon market over 1975-76, which dropped while that in Alaska turned upwards. The great majority of snowmobiles to Inuit communities in the NWT are delivered by sea-lift during the summer. This increases the probability of large carry-overs of inventory, if demand is over-estimated and, conversely, suppressed sales, if demand is under-estimated.

The figures for the more readily accessible Alaska market are comparatively consistent between the years 1975 and 1981, those for the Territories are comparably consistent between the years 1977 and 1981. This degree of consistency is noticeable when compared to the situation obtaining in the general market - a steady decline punctuated by wide fluctuations.

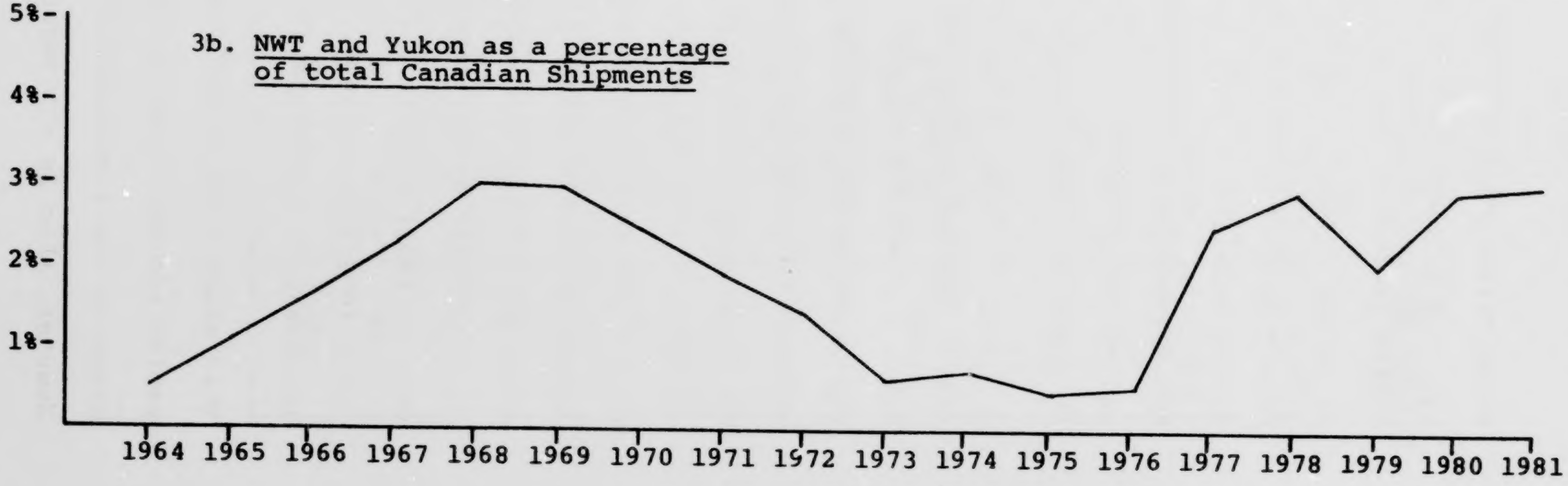
Figure 3 illustrates a further feature of the relationship between northern and southern markets. Fluctuations in northern

Figure 3

SNOWMOBILE SHIPMENTS TO NORTHERN MARKETS AS PERCENTAGES OF TOTAL SNOWMOBILE SHIPMENTS



3a. NWT, Yukon and Alaska as a percentage of total shipments



3b. NWT and Yukon as a percentage of total Canadian Shipments sales reflected those that occurred in the southern markets, but less intensely. Furthermore, as sales in the recreational market increased, the proportion of the total market disposed of in the north tended to decrease. Most significantly of all, Figure 3a shows that the proportion of the total market shipped to the Territories and Alaska has now reached its highest level and appears to be on the increase. Moreover, the figures presented here reveal this market, though numerically small, to be significantly more stable than the total snowmobile market.

2.2.3. Changes in the Number of Snowmobile Manufacturers

Table 2 shows the significant changes in industry structure that have accompanied the changes in market size discussed above. Ten years ago, the industry could be said to be dominated by firms located either in Quebec or in the United States (most of these in the mid-west). During that period, the average output per manufacturer was about 15,000 units and the average number of models was 6, yielding an average production run per model of 2,500. This apparent capacity to produce small runs of snowmobile models existed at a time when snowmobile sales were at their highest. It was only later, as sales commenced their long-term decline, that productive capacity became increasingly concentrated in the hands of a few firms.

This might lead to the presumption that the few remaining companies are too committed to large production runs to be able to cater to small markets such as the Arctic utility market. However, this is not necessarily so; the same calculations

Table 2

CHANGES IN THE NUMBER OF SNOWMOBILE PRODUCERS AND THE MODELS PRODUCED, 1970-82

Season	Number of producers	Location of producers				Models produced
		Quebec	Ontario	United States	Japan	
1970/71	38	8	1	28	1	258
1971/72	27	12	2	12	1	248
1972/73	28	10	1	16	1	235
1973/74	29	8	2	17	2	222
1974/75	23	8	1	13	1	145
1975/76	18	6	1	10	1	121
1976/77	10	1	1	6	2	75
1977/78	7	1	-	4	2	60
1978/79	7	1	-	4	2	54
1979/80	7	1	-	4	2	61
1980/81	7	1	-	4	2	54
1981/82	5	1	-	2	2	44
1982/83	4	1	-	2	1	N/A

applied to last year's figures for models and units produced yield an average of 4,000 units per model. What is at stake may be not so much a manufacturer's need to have large runs to justify production of any single model as the need for large total sales - of all models produced. Also of significance is whether models are distinguished 'cosmetically' or by basic structural character; this question will be discussed further in Chapter 4.

2.2.4. Explanations given for recent decline in total sales

A number of explanations have been proffered at one time or another either to explain the general sales decline since the peak of 1970/71 or the more recent decline which followed the apparent recovery between the years 1977 and 1979. Whether or not the present trend will continue is of importance for the utility snowmobile market for the greater the general decline, the more likely that manufacturers will pay close attention to the demands of Arctic utility users. The factors which are believed to be responsible for the decline in sales are summarized below.

Economic factors often cited are: the increasing costs of fuel, the increasing costs of snowmobiles themselves, a general withdrawal from large 'luxury' purchasing, high interest rates, recession. It should be mentioned that estimates of the annual costs of fuel for recreational snowmobiling are in the area of $200, a relatively small amount in comparison with the capital and depreciating costs of snowmobiling. Some dealers whose opinions were canvassed in this study expressed the view that those people who already possess snowmobiles have found it cheaper to overhaul present machines rather than trade them in for new models. IASA reports that there is virtually no second hand trade in snowmobiles through dealers; most of such sales are made privately.

A second cluster of explanations refers to the status of snowmobiling as a sport. During the early 1970's when sales were at their highest, the industry endured a series of regulatory battles, on the questions of noise emissions, safety, and environmental impact. Though the industry survived, by reducing noise levels, enforcing safety requirements and going to considerable lengths to confine snowmobile travel to recognised trail systems, it is arguable that the sport only survived with a certain stigma attached - and significantly reduced scope for attracting new adherents. While snowmobiling was struggling to establish itself as a legitimate sport, cross-country skiing has emerged as a major participant sport, partly in reaction to escalating costs of downhill skiing, partly as part of broadening interest in physical fitness sports.

Not only has snowmobiling been affected by growing interests in cross-country skiing, but, in the area of mechanised sports, is now facing direct competition from the use of three-wheeled all terrain vehicles. These vehicles (see Annex 1) are capable of traversing groomed snowmobile trails and have done so to such an extent that ISIA has recommended that these machines be excluded from the trails as the two vehicles are not compatible on such prepared surfaces. Sales of off-road three-wheelers were estimated at 80,000 in 1979 and 100,000 in 1980 (ISIA 1981). These machines tend to be more economical, cost less, and, most of all, can be used all year over a wider variety of terrain types than snowmobiles. Respondents to the survey undertaken by ISIA acknowledged that, apart from their choice of machine, the riders of three-wheelers and snowmobiles had much in common. Undoubtedly, such machines offer a powerful alternative attraction to those persons inclined towards mechanised recreation who can afford it.

Dealers and manufacturers consulted in this study partially attributed the sales decline since 1979 to two poor snow winters in succession. This winter, 1981/82, has, since late December become an excellent snow winter and the manufacturers are hoping that sales, which were conforming to the recent pattern of decline until December, will revive in the new year and justify the view that availability of snow is the overriding factor determining sales levels.

At the time of completion of this study, total shipment figures have become available to the end of February 1982. These are 141,000. They strongly indicate a continuation of the long-term decline in sales, despite this winter's generally excellent snow conditions.

2.2.5. The significance for the utility market of the decline in sales

It would be tempting to conclude that the decline in total sales will oblige manufacturers to take more seriously the requirements of the utility market, as it assumes a progressively larger proportion of the total market. On the other hand, the decline may continue to the point where the production of any kind of snowmobile becomes economically unfeasible at current price levels.

In fact the first point appears already to have been reached, and manufacturers have begun to take account of the small but stable Arctic market. When questioned about what they intended to do by way of serving it, manufacturers made quite positive declarations, either of an intention to produce suitable utility models (see subsection 2.3.4. below), or of an intention not to do so on economic grounds.

Those manufacturers who have decided to cultivate the Arctic market have generally done so by modifying current production machines rather than by designing models that are radically different. The former is regarded as the more cost-effective approach, but it, of course, raises the question of the extent to which the 'ideal' utility machine can be put together from elements primarily designed for recreational snowmobiling. Chapter 4 will deal with this problem in more detail and will attempt to distinguish between utility improvements which are within the scope of existing production tools and methods and those which would require expensive re-tooling.

2.2.6. Currently available snowmobile models

To complete this historical account of the snowmobile industry in general, a listing is provided in Table 3 of those models currently available. The table includes Arctic Cat and Scorpion 1980/81 models as these are still available this season and because the future of these model ranges continues to remain in doubt.

Selected models have been annotated and will be re-considered in greater detail at the close of chapter 4 (see Table 9). Those models that are annotated fall into four general groups:

*A - Models which for a long period have been produced as utility machines.

*B - Recent models, advertised as utility or dual purpose machines.

*C - Models which, though not designed primarily as utility snowmobiles, have acquired a reputation as dependable working machines.

*D - The smallest and cheapest models.

These models will be combined later in Table 9 with other projected or prototype utility models in an attempt to arrive at a profile of the most practical working snowmobile.

When the two *A type utility machines, the Bombardier Elan and Alpine, are excluded from consideration, the data listed in Table 2 indicate the extent to which there has been a convergence in snowmobile design since the basic configuration became established in the late 1960's. All the remaining models employ slider suspension (with the exception of the Scorpions, now out of production); the great majority use capacitor discharge

Table 3: CURRENTLY AVAILABLE SNOWMOBILE MODELS AND THEIR MAJOR ATTRIBUTES

	MAJOR DESIGN FEATURES											
MODEL NAME	Weight k	Displacement cc	No. Cylinders	No. Carburetors	Cooling (A) air (F) fan (L) liquid	Starting (M) manual (E) electric E/M both	Ignition (C) CDI (B) breakers	Fuel Mixing (P) pre-mix (I) oil injection	Suspension (B) bogie (S) slider (P) pararail	Track length	Track width	Price $
Bombardier												
*A *B ELAN	129.2	250.4	1	1	F	M	B	P	B	289.6	38.1	1849
CITATION 3500	156.6	268.7	1	1	F	M	C	I	S	269.2	38.1	1979
CITATION 4500	169.3	368.3	2	1	F	M/E	C	I	S	289.6	38.1	2649
CITATION SS	172.0	368.3	2	2	F	M/E	C	I	S	289.6	38.1	2949
*B NORDIK	172.4	368.3	2	1	F	M	C	P	S	315.0	38.1	2849
*B SCANDIC	193.4	368.3	2	1	F	M	C	P	S	353.0	38.1	2949
*C EVEREST 500	208.2	496.7	2	1	F	M/E	C	I	S	315.0	41.9	3449
EVEREST L/C	229.6	462.8	2	1	L	E	C	I	S	315.0	41.9	3999
BLIZZARD 5500MX	190.9	496.7	2	2	F	M	C	I	S	289.6	41.9	3649

Table 3: cont.

	BLIZZARD 9500	200.0	43.6.	2	2	L	M	C	I	S	289.6	41.9	4349
*A	ALPINE	292.8	635.1	2	1	F	E	B	P	B	353.0	76.2	4899
	Yamaha												
*D	BR250F	128.0	246.0	1	1	F	M	C	I	S	238.0	38.0	1699
	BT300F	157.0	294.0	2	1	F	M	C	I	S	259.0	38.0	2249
*C	ET340F	165.0	338.0	2	1	F	M	C	I	S	275.0	38.0	2599
	EC340F	173.0	338.0	2	1	F	M/E	C	I	S	275.0	38.0	2800
*B	ET340TF	184.0	338.0	2	1	F	M	C	I	S	342.0	38.0	2899
	SS440F	181.0	437.0	2	1	F	M	C	I	S	294.0	38.0	3499
	EC540F	218.0	535.0	2	1	F	M/E	C	I	S	317.0	42.0	3599
	SR540F	N/A	535.0	2	1	F	M	C	I	S	307.0	38.0	3999
	SKX500F	N/A	499.0	2	2	L	M	C	I	S	207.0	38.0	4899
	John Deere												
	SPITFIRE	129	338	2	1	A	M/E	C	P	S	295	38	2399
	TRAILFIRE	174	339	2	1	F	M/E	C	P	S	295	40	3699
	TRAILFIRE LX	176	436	2	1	F	M/E	C	I	S	295	38	3699
	SPORTFIRE	179	436	2	1	F	M/E	C	I	S	295	38	3899
	LIQUIFIRE	187	436	2	2	L	M	C	I	S	295	38	4899

Table 3: cont.

Polaris												
TXL340	181	333	2	2	L	M	C	P	S	307	38	4339
TXLINDY 340	193	333	2	2	L	M	C	P	S	307	38	4769
CUTLASS SS440	172	432	2	1	F	M/E	C	I	S	279	38	3399
TXC 440	178	432	2	2	F	M/E	C	I	S	307	38	3989
TXLINDY 500	181	500	3	2	L	M	C	P	S	307	38	5449
Kawasaki												
INTRUDER 440	190	436	2	2	F	M	C	I	S	307	38	3699
LTD440	200	436	2	2	L	M/E	C	I	S	307	38	4499
INTERCEPTOR 540	200	530	2	2	L	E	C	I	S	295	38	5199
Arctic Cat (1980/81 models)												
JAG4000	180	431	2	1	F	M/E	C	I	S	278	38	2899
PANTHER 5000	180	431	2	1	F	M/E	C	I	S	290	40	3199
TRAIL CAT	176	431	2	1	F	M/E	C	I	S	278	38	3399
PANTERA	177	500	2	1	F	M/E	C	I	S	278	38	3499
EL TIGRE 5000	174	500	2	2	A	M	C	P	S	278	38	3499

Table 3: cont.

EL TIGRE 6000	187	500	2	2	L	M	C	P	S	278	38	4199
Scorpion	(1980/81 models)											
TK340	169	339	2	1	F	M	B	P	P	284	38	2699
TK440	169	428	2	1	F		B	P	P	284	40	2699
WHIP	164	428	2	1	F	M	B	P	S	284	38	2599
STING 440	164	428	2	1	F	M	B	P	S	276	38	2799
SIDEWINDER	185	436	2	1	L	M	C	P	S	276	38	3999

ignition, oil injection, and track widths of 38cm. Not all of these features are detrimental to utility usage; in Chapter 4, greater detail will be provided upon the evolution of snowmobile design and the degree to which this has benefited recreational and utility usage respectively.

Figure 4 illustrates the distribution of model prices. It is noteworthy that, in the range below $2,500 choice is limited to only 5 of the total of 38 models made available for the 1981/82 season.

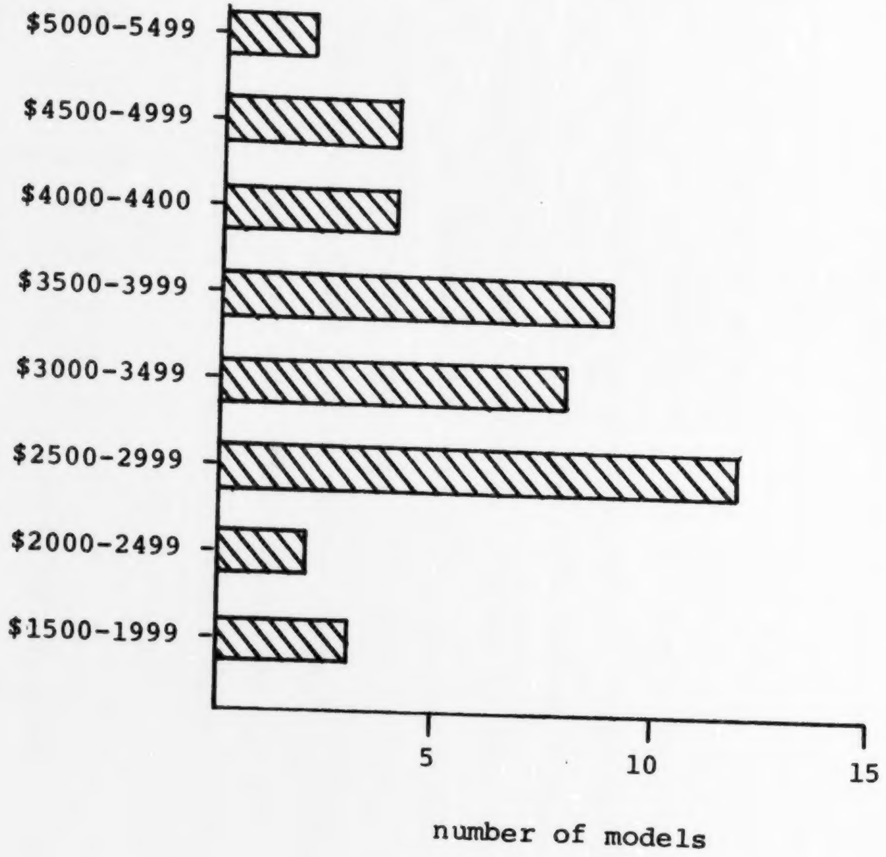
The average price of these models is $3,478, and the highest priced machines exceed $5,000 - more than the cheapest cars on the Canadian market. Such prices appear comparatively high when a snowmobiles' projected lifetime mileage (8-12,000 km.) is compared with what is usually expected from an automobile. However, though they cover less distance than automobiles, snowmobiles are estimated, by ISIA, to last much longer with average recreational usage - 8 years - than cars. For a recreational snowmobiler, $3,478 amortized over eight years is clearly less of a burden than this figure amortized over one year - as it may be for many regular Inuit users.

2.3. THE SNOWMOBILE INDUSTRY IN THE ARCTIC

This section describes the major dealer distribution systems in the Arctic, typical facilities for service and repair and the situation regarding supplies of spare parts. Also, an approximation will be made of the size of the market in communities north of the tree-line. The section will conclude with

Figure 4

PRICE RANGES OF MODELS OFFERED 1981/82



a summary account of the efforts that manufacturers have made to discover and respond to the special requirements for Artic utility applications.

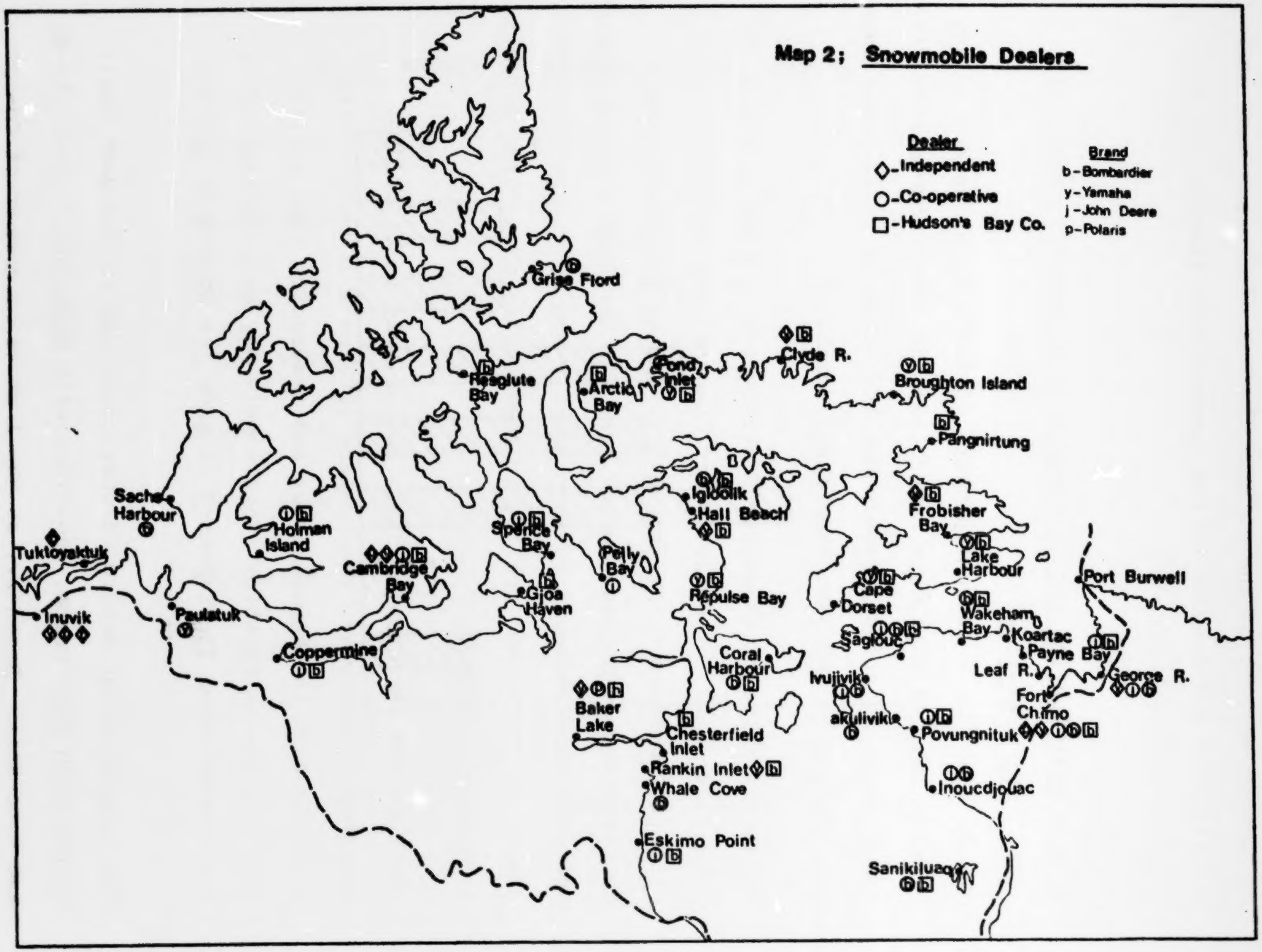
2.3.1. Distribution and aquisition of snowmobiles north of the tree-line

Map 1, provides a current picture of patterns of access to new snowmobiles. It should be noted that, in those communities with ready southern access, people may buy these or other makes outside the study area and have them flown north.

There are three major dealer/distribution systems north of the tree-line: (1) the Hudson's Bay Company, (2) Canadian Arctic Cooperative Federation, in the NWT, and La Fédération des Coopératives du Nouveau Québec, and (3) the Yamaha Motor Company. The general picture is further complicated by the practice of casual or 'one-time' dealing in snowmobiles that takes place from time to time.

The Hudson's Bay Company deals exclusively in Bombardier machines. Each year, the Company obtains a large quantity directly from the manufacturer and transports them to its northern stores by ship. This supply may be supplemented by air freight when local demand exceeds the available supply.

The Federation of Arctic Co-operatives has in the past dealt mainly with John Deere, sometimes with Bombardier (both Ski-doo and Moto-ski). Recently, as Map 1 shows, a number of Co-ops in the NWT have switched to Yamaha snowmobiles.



Map 2; Snowmobile Dealers

Over the last few years, the Yamaha Motor Company has established a dealer network north of the tree-line. This at first comprised four regional dealers: Inuvik, Cambridge Bay, Rankin Inlet, Frobisher Bay. The intention was for these dealers to supply those settlements linked by regional air lines. Buyers could then exercise the option of having their new machines flown in or they could drive them home. However, there are now twelve Yamaha dealerships. Of the 8 added to the original 4, 5 are Co-ops.

Other makes of snowmobiles than Bombardier, Yamaha and John Deere are less consistently represented. There appear to be no active Kawasaki dealers, Polaris dealers are placed in two locations, and Arctic Cat in two.

Occasionally someone in a settlement will obtain a batch of machines and dispose of them locally, thereby obtaining one or two 'free' machines. Also, in settlements with better southern connections, residents will often order their machines directly from the south and have them flown up. Yellowknife and Montreal are frequent sources for this trade. Some settlements and camps have no local access at all and must rely on dealers in other settlements.

Not surprisingly, the dealers able to take advantage of sea-lift for bringing snowmobiles north enjoy a distinct advantage over those obliged to rely upon air freight. When Willie Emudluk sells an Arctic Cat in George River, he must sacrifice almost 90% of the regular dealer profit in order to remain competitive.

The small local dealers interviewed in this study were all placed in a similar situation; lacking the capital to maintain an inventory and having to shave their margins to stay in business.

The larger and more extensive dealer networks possess a further advantage over the local independent dealers in that they have the resources to extend credit to customers. This, of course falls within the traditional northern practice whereby a trader would outfit a trapper to be later repaid in furs. Precise details of the extent of credit purchases could not easily be obtained during this survey. All that can be said is that John Deere operates a financing process through the Federated Co-op System, the Hudson's Bay Company extends credit on occasion, Yamaha dealers need not pay for their shipments until the January following sea-lift.

2.3.2. Facilities for service and repair and the supply of spare parts

Routine maintenance of snowmobiles, and many of the more common replacement or repair jobs, can be done without specialised tools and, in fact, most of those who use snowmobiles regularly for hunting are accustomed to carrying out their own repairs. One Bay store manager actually reported that his customers were not willing to entrust their machines to the mechanic who was on hand for work that may be required under warranty arrangements. Where special facilities or tools are required, the owners usually prefer to simply gain access to such facilities rather than have someone else operate them.

Dealers with whom this problem was discussed were fairly consistent in their view that, in the smaller settlements (that is most communities other than Frobisher Bay and Inuvik), there is simply not enough demand for a full-time snowmobile mechanic, even if he were to service all makes of machine. On the other hand, some kind of trained competence is required to deal with warranty claims.

Such claims must first be assessed, sometimes a delicate problem, and then dealt with. Sometimes the claimant will not want the mechanic/assessor to work on his machine but simply wishes to be given the replacement part - which, though it may save the dealer work, violates the proceedure for responding to warranty claims and may make him liable for further claims. While dealers who handle only snowmobiles will usually have someone available who can deal with such problems, general merchandising operations such as the Hudson Bay stores must go to special lengths to set up mechanics and facilities. The manager of one such store, which had a respectable sales volume, simply stated that the snowmobile side of his business was just not worth the effort when compared with the returns from his trade in other commodities.

Throughout the study area, independent snowmobile dealer/repair enterprises, not directly linked to a manufacturer or a merchandising system, were the exception rather than the rule and most of those encountered relied on some other source of income in addition to the income from their snowmobile business: running a local bus or taxi service, operating the local fuel franchise, or holding a job in agencies such as the Department of Public Works.

Several respondents expressed the view that, if the work related to all makes of snowmobile were to be combined with attending to outboard motors, three-wheelers and the occasional light truck, there might be sufficient work in most settlements to support a full-time fully trained mechanic.

Though this might be an agreeable situation, a detailed investigation of the prospects lies beyond the scope of this study. A more simple alternative might be the provision of facilities where snowmobiles and other machines could be worked on by their owners when their domestic facilities are inadequate. This has happened informally in some communities where the Hunters and Trappers Associations are fortunate enough to possess facilities which could be used as a workplace. Such facilities are sometimes adjacent to the office/garage of the local wildlife officer where, in one place or another, the owners of snowmobiles may occasionally be found working on their machines in the evenings.

A 'snowmobile problem' which is less susceptible to this kind of informal local resolution is the supply of spare parts, not so much those such as belts and plugs which are in fairly constant demand, but those parts which may be less regularly stocked, such as starter pulleys or pistons. Two years ago, at the Annual General Meeting of the Kitikmeot (Central Arctic) Inuit Association, Cambridge Bay, the Hunters' and Trappers'

Association described this as a serious problem, not so much in Cambridge Bay, which has a direct air link to Yellowknife, but in those central Arctic communities served by regional airlines through Cambridge Bay (see Map 1). The Hunters' and Trappers' Association recognised that this was principally an economic problem, the costs of maintaining a comprehensive spare parts inventory, and were at that time considering applying for funding to establish its own supply service.

In establishing its regional dealership, the Yamaha Motor Company addressed this problem by committing its dealers to have any part requested from an outlying settlement on the next flight by the regional airline, providing, of course that the part is stocked at the regional facility.

2.3.3. An approximation of the size of the market north of the tree-line

The following estimate should be treated with caution as there is no precise way of measuring how many snowmobiles are sold each season. Individuals may order machines from the south, parts of inventories may be held over unsold until next season, batches of machines may be flown from one settlement to another and recorded twice. However, a general and qualified approximation is worth attempting since so many of the manufacturers' representatives interviewed in this study stated that the size of the Arctic market is critical in determining how much effort manufacturers will spend to meet its demands.

The estimate attempted here extends over the NWT and Northern Quebec. As a starting point, the ISIA records of shipments to the Territories show an average of approximately 2,000 units per year over the five seasons, 1976-81. We were provided with figures for shipments by the Yamaha Motor Company to their northern dealers, but unfortunately directly comparable data from other manufacturers to dealers could not be obtained as these transactions are either mediated through major distributers such as the cooperative federations or the Hudson's Bay Company, or made on a local/regional opportunity basis. However, the Fédération des Coopératives du Nouveau Québec provided us with similar data, which concerned Bombardier and John Deere Snowmobiles. Cooperatives in the Territories were all called individually, with the results showing a mix of all currently available makes of snowmobiles. For data on Bombardier machines sold through the Hudson's Bay Company, all the stores were contacted. Some managers were freshly appointed and unfamiliar with the local market or the sales volumes of their predecessors; a few were disinclined to provide information. Some sources were kind enough to provide the information required but requested that full details not be revealed unless precisely similar data is also tabulated for their competitors. This consistency could not be achieved under the survey circumstances and therefore the data provided below is listed without reference to specific makes or models.

The figures presented in Table 4 are, like those in Table 1, for snowmobiles shipped into the communities. We did obtain figures

Table 4: COMPILATION OF DATA ON SNOWMOBILE SHIPMENTS AND THEIR RELATION TO POPULATION

SETTLEMENT	TOTAL SHIPPED	LOCAL POPULATION	NUMBER OF INHABITANTS PER SNOWMOBILE	COMMENTS
N.W.T.				
Igloolik	32	843	26	new management data uncertain
Pond Inlet	53	708	13	-
Resolute Bay	6	206	34	some ordered elsewhere
Lake Harbour	32	306	10	-
Clyde River	44	471	11	-
Broughton Is.	21	398	19	-
Arctic Bay	7	474	67	uncertain data
Grise Fiord	2	110	67	machines ordered elsewhere
Hall Beach	4	400	100	machines bought in Igloolik
Pangnirtung	72	995	14	-
Frobisher Bay	69	3255	47	-
Sanikiluaq	28	366	13	-
Rankin Inlet	108	1289	12	some sold elsewhere
Baker Lake	115	1163	10	-
Chesterfield In.	7	292	42	some bought in Rankin Inlet
Coral Harbour	51	532	10	-
Eskimo Point	41	1019	25	some bought in Churchill
Repulse Bay	34	338	10	-
Whale Cove	4	208	52	some bought in Rankin Inlet
Cape Dorset	79	782	10	-

Table 4: cont.

Cambridge Bay	108	969	9	some sold elsewhere
Coppermine	69	916	13	-
Holman Is.	29	349	12	-
Pelly Bay	1	295	295	most bought Cambridge Bay
Spence Bay	36	536	15	some ordered from Cambridge Bay
Gjoa Haven	28	519	18	-
Tuktoyaktuk	N/A	-	-	-
Paulatuk	15	183	12	some ordered elsewhere
Sachs Harbour	7	197	28	some ordered elsewhere
N.W.T. Sub-Totals	1,144	18,118	16	
Québec				
Great Whale	20	644	32	some bought elsewhere
Inoucdjouac	33	745	22	-
Fort George	0	69	-	ordered elsewhere
Povungnituk	41	704	17	-
Akulivik	26	188	7	-
Fort Chimo	138	976	7	some sold elsewhere
Leaf Bay	0	102	-	ordered elsewhere
George River	30	315	10	-
Payne Bay	30	277	9	-
Port Burwell	0	70	-	ordered elsewhere
Koartac	0	,136	-	ordered elsewhere
Wakeham Bay	24	273	11	-

Table 4: cont.

Ivugivik	20	179	9	-
Sugluk	40	495	12	-
Québec Sub-Totals	402	5,212	13	
TOTAL	1,546	23,330	15	

for units sold so far and for those still on inventory, but, in the month, February, when the survey was made, most dealers fully expected sales to pick up with the onset of Spring.

For each community, the population estimates are listed. For the NWT, these are extrapolated from Hamelin's (1979) projections for population increases between 1978 and 1986. For Northern Quebec, the figures were provided by Makivik Corporation.

In calculating the relationship between snowmobile shipments and local populations, the intention was to see if any consistent ratio would appear, which could be applied to estimating demand on the basis of population. This ratio varies widely bewteen settlements. Where local snowmobile sales were low in relation to population, respondents either refered this to lack of local outlets (e.g. Pelly Bay, Grise Fiord) or to the fact that local residents were accustomed to acquiring their snowmobiles from dealers in nearby settlements (e.g. Whale Cove from Rankin Inlet, Hall Beach from Igloolik, Sachs Harbour from Inuvik). Where sales are high, the presumption may be that the settlement acts as a source of snowmobiles for Inuit residing elsewhere (e.g. Cambridge Bay).

However, when shipments to all the NWT settlements returning data are compared with the population in those settlements, the ratio of one snowmobile for every 16 persons is obtained. In Northern Quebec, where the data on sales and shipments was more consistent and reliable, the comparable ratio is one snowmobile for every 15 persons.

If snowmobile shipments are compared with the number of Inuit men of working age (15-65) projected for the NWT, for settlements listed, the ratio is approximately 1 machine for each 4 men (the comparable ratio in the age group 20-60 years is 1:3).

For the 1976, Inuit Land Use and Occupancy Study, Freeman (1976) estimated the total number of "adult Inuit hunters" in the NWT to be in the neighbourhood of 2,000. The total Inuit population increase 1976-81 has been estimated at 17% (Hamelin, 1979). If this figure is increased by this percentage, the resulting ratio is one machine shipped for every two hunters. The comparable figure for the machine/hunter ratio in Northern Quebec is 402/580, or 1:1.5.

These figures are deliberately kept general and conservative. They do not include snowmobiles ordered from the south by individuals, or fetched from locations outside the study area, such as Churchill.

Nevertheless, there is consistency enough in the data to support two conclusions. The first is that the snowmobile market in the study area is in the order of 1500-1600 units. Second, the ratio of new machines to the number of people regarded by authoritative sources as hunters is high and suggests an extraordinarily high rate of turnover.

2.3.4. Manufacturers' efforts to discover and respond to the requirements of the Arctic utility market

All the manufacturers currently producing snowmobiles were asked about their perspective on the Arctic utility market, whether or not they had made particular efforts to discover its special requirements and to respond to them by modifying existing machines or designing new models. With one exception, all the manufacturers had made such efforts in recent years. Kawasaki's position* was that the company is currently committed to a limited annual production of 5,000 units and at this level economics of scale would not permit them to produce a competitive utility machine. The efforts undertaken by other manufacturers are described below: overall, the results support the view that producing an Arctic utility snowmobile is an economic rather than a technical problem.

In 1979, production engineers from Polaris visited several Alaskan communities to find out what kinds of features users felt should be incorporated in a snowmobile suitable for hunting, fishing and trapping. Using the information gained, the company constructed two prototype models based upon two current models, the Cutlass and the Galaxy (see Photos 1 to 6). The prototypes had elongated tracks, reinforced bodywork, enlarged windshields, heavy duty towing hitches, extra wheels supporting the tracks, pusher plates at the front end, kick stands to jack the track off the snow, reduced gearing, larger fuel tanks and standard 440 twin-cylinder engines.

The prototypes were displayed at the 1980 dealer convention in Winnipeg. However, in spite of enthusiasm over the machines as utility vehicles, the projected prices were such that not enough dealers were willing to place the volume of orders required to

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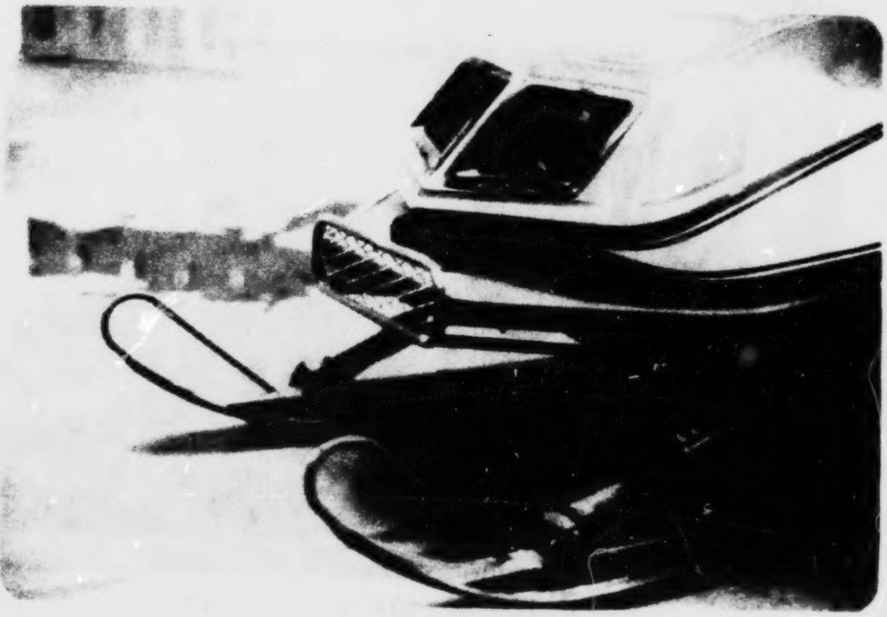
* Kawasaki has since withdrawn from all snowmobile production.

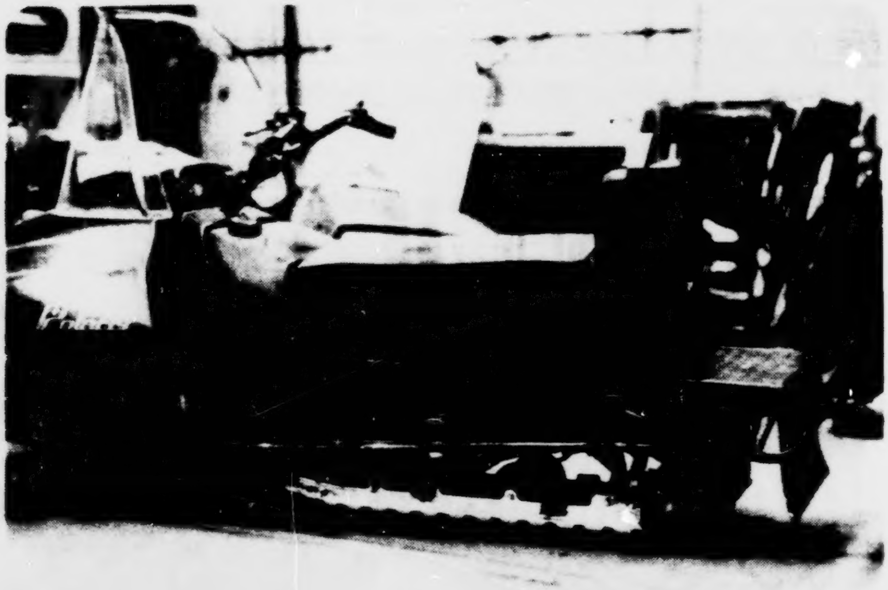
Photos 1-6

DETAILS OF UTILITY PROTOTYPES BUILT BY POLARIS AFTER USER RESEARCH IN ALASKA

1. The two prototypes

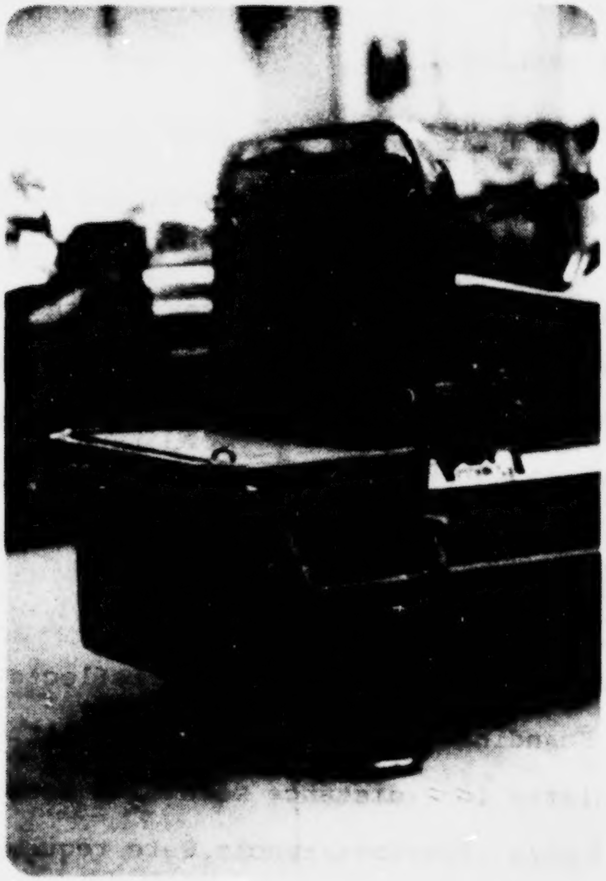


2. Reinforced skis, front & pusher plate

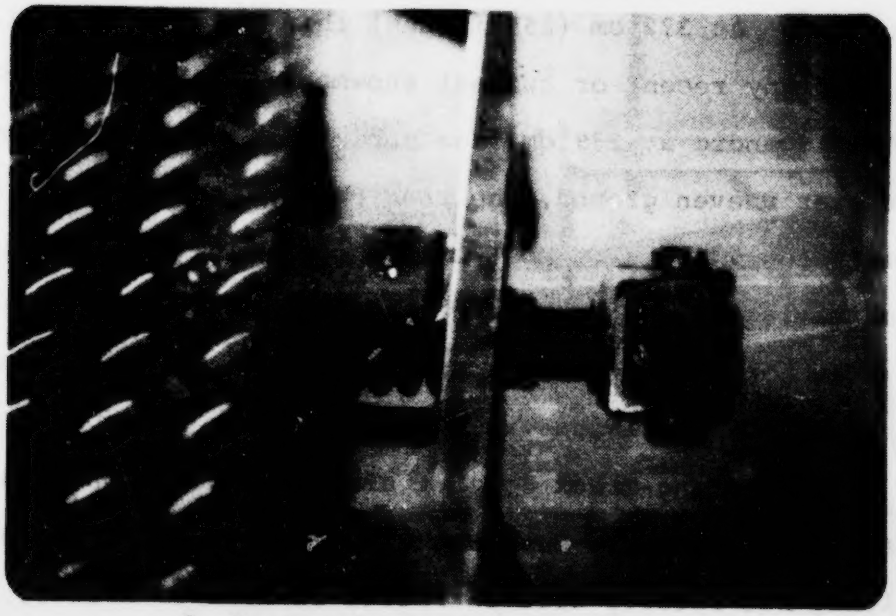


3. High, wide, windshield

4. Extra baggage area



5. reinforced rear end, baggage area, kickstand.



6. Heavy-duty spring hitch

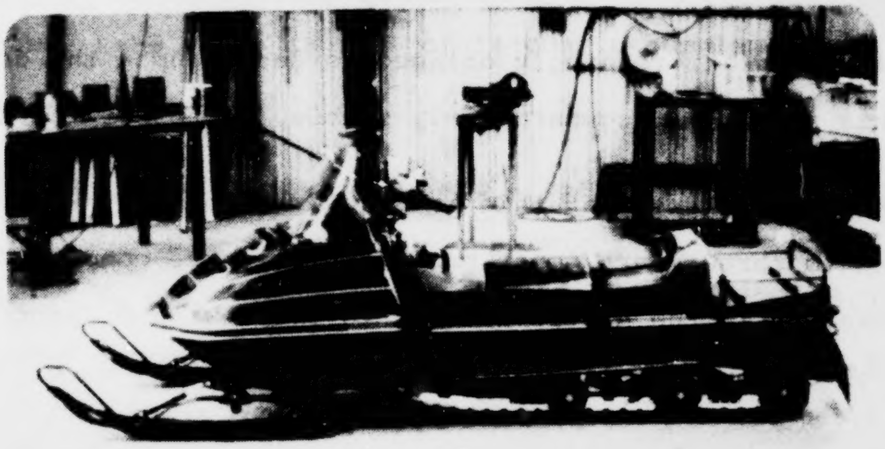
justify producing the machines.

John Deere undertook a similar market research planning exercise in the Canadian Arctic. This led to the production of the Arctic Trailfire Special, a modification of the Trailfire. This model is distinguished by extra wheels to reduce wear on the sliders, adjustable roller idler on the chain, protected chain case, fuel primer pump, enlarged windshield, on/off light switch, heavy duty hitch, steel instead of aluminium steering components, reinforced fron suspension, fuel shut-off valve and a standard 340 twin-cylinder engine.

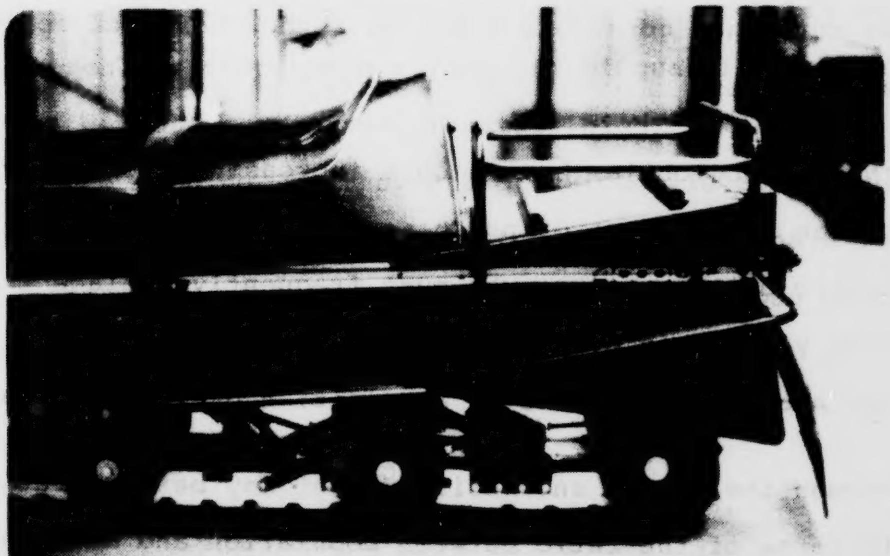
Arctic Cat's production of utility snowmobiles reflects that company's experience in Scandinavia. For that use, pulling is also at a premium, particularly long-distance movements keeping pace with reindeer herds. Long, flexible tracks were requested, and the company produced a special version of its Jag, the Long-Track Jag. At 372 cm (155 inches) this model has the longest track of any recent or current snowmobile (closest is the Bombardier Scandic at 239 cm, see Table 3). To maintain optimum contact over uneven ground, the rear part of the track is hinged (see Photos 7 and 8). Most of the run of this model was sold in Scandinavia, but a few remain in North America. Though the company has formally ceased production, at the time of compiling this report, Polaris has acquired the assets and plans to produce not only the Long-Track Jag but also a similar long-track version of the Arctic Cat Panther. This plan may now be shelved, but Polaris will introduce in 1982/83 a long, hinged track on a modified version of its Cutlass (see Table 9).

Photos 7-8

ARCTIC CAT LONG-TRACK JAG - DEVELOPED FOR WORKING USE IN SCANDINAVIA



7. Long-track Jag, side view.



8. Close-up, hinged track section.

2.3.5. The snowmobile industry - concluding remarks

The decline in the recreational snowmobile market, which as yet snows no sign of reversing itself, may turn out to be beneficial from the point of view of Arctic utility users as manufacturers may become increasingly obliged to depend upon the demands of this small, yet comparatively stable, sector of the total market.

There are signs that this is already happening. Over the last two to three years, most manufacturers have conducted market research in the Arctic leading to the design of prototypes, modified current models or new models, advertised as utility machines.

At present the primary factor affecting the introduction of utility machines appears to be the economics of production in relation to the size of the utility market, rather than technical innovation; the manufacturers feel that they know *how* to produce tougher, more utilitarian machines but they are not so sure that consumers would bear the increased costs of such snowmobiles.

Though snowmobiles have become increasingly expensive, the effect of the intial cost of purchase is felt far more severely by Arctic utility users, who must frequently replace their machines each year, than by the average southern recreational user who may amortize the costs of acquisition over eight years.

Though the Arctic snowmobile market may be comparatively dense, in terms of the ratio between population and machines and the turnover of machines, the total number in any one location is not usually sufficient to support snowmobile dealing as an independent business. Snowmobile dealing is either conducted along with general merchandising, as with the Hudson's Bay Company, or is integrated with informal local economies, whereby a dealer may have other sources of income to supplement that from snowmobile sales.

Qualified snowmobile mechanics are a rarity in the study area, but, in fact the demand for their services may be more for assessing the validity of warranty claims and for providing and performing warranty work, than for other repairs. Most owners prefer to do their own repairs (this may be a consequence of experience of the shortage of qualified mechanics). It is conceivable that snowmobile owners would be more interested in obtaining access to repair facilities than they would be to qualified mechanics.

The supply, and the prices, of spare parts are probably more critical problems than the availability of qualified mechanics. The prices can be as disproportionately high, in relation to their cost on a new machine, as they are on automobile and, however, high the prices, it is not unusual for an owner to have to wait several more months for a spare part other than those which are stocked as a matter of course.

3. INUIT USAGE

> When they started getting skidoos, people decided that they could not keep their dogs going. When you try to keep dogs, the policeman just shoots that, so we turn to metal things that cannot be shot. You break them up yourself, or bump somebody with them . . . . By using a skidoo as your means of transportation, you tend to sharpen your own senses: smell, eyes, your sense of direction in the dark or in a storm, and your prediction of weather. These things were not really sharp before, because you had dogs. If you were going to go somewhere, they would probably know which way to go anyway, because all the things you knew went to the leader and he recorded where he had been before. Dogs used to be valuable for ice. They learnt to walk on different kinds of ice. Today, you cannot get a skidoo to walk on different kinds of ice. You have to try and analyse that ice yourself, before you go on it with the skidoo. That way you sharpen your sense - senses that were not so sharp before.
>
> William Kalleo, Nain
> Brice-Bennett, 1977:323

3.1. TRACTIVE PERFORMANCE

The most consistent distinction between Inuit use of snowmobiles and southern recreational use is that the machines should be capable of pulling heavy sleds for considerable distances, over far roughter terrain than the groomed trails for which the majority of modern machines are designed. This was stated to be the basic requirement; for the snowmobile to be useful as a tractor. Further to this, there were more specific purposes which enabled a rough categorisation to be made of three major machine/use types.

The first category is of machines capable of pulling loads of a ton or more at steady speeds over long trap-lines. The machine's suitability for other purposes is secondary. At present, the Bombardier Alpine is the only machine capable of providing this level of performance.

The second kind of use respondents refered to was for a small, maneuverable, machine which would handle well in deep snow, in hilly terrain and amongst trees. The Bombardier Elan is widely perceived to fulfill these purposes best, though some Elan owners allowed that they would prefer the Alpine if they could afford the extra (triple) cost.

At present, these two categories are more or less dominated by these two models. They have both been on the market for over ten years and owners tended to identify the pattern of use with the machine to which they had become accustomed. In the small machine category, there is now competition to the Elan; how effective this will be remains to be seen.

The third category is the market segment at which the range of machines discussed in subsection 2.3.4. is aimed. The requirement here is for a machine capable of pulling around 450 kg (1000 lbs.) yet also capable of a fair turn of speed - approaching 100 km/h (63 mph). The extent to which such speeds are reconcilable with such lugging properties is perhaps the most difficult design problem in producing such an all-round kind of machine.

A load of 450 kg (1,000 lbs.) was the most common figure advanced as a minimal capability. Muller-Wille (1978) found that Repulse Bay hunters were used to pulling the same weight in the early 1970's, and Usher (1972) in noting that the Bankslanders also pulled such loads, observed that 450 kg (1,000 lbs.) was about the payload that could be pulled by a full team of 9 dogs.

Payloads of this magnitude are considerably higher than those for which snowmobiles are designed. Even the Bombardier Alpine, when tested for military purposes, was limited to a load of about 200 kg (450 lbs.). Manufacturers with whom the question of tractive power was discussed were well aware of the loads that are customarily pulled in the course of Arctic use, and are willing to provide for this by strengthening hitches and lowering gear ratios, but they are disinclined to advertise specific figures for tractive capacities on account of warranty problems that might arise.

3.2 VARIETIES OF USE

Of the various uses to which snowmobiles are put in the course of hunting, trapping and fishing, trapping is perhaps the least demanding in the sense that the trapper will be proceeding at a steady and moderate pace over a regular route during a period in the winter when the snow cover is the most extensive. On the other hand, trapping may account for greater distance covered than other forms of use.

At various times throughout the winter, people may fish with nets below sea and lake ice. In many places, a typical weekend trip will be to and from a fishing camp which may be well over 160 km (100 mi.) from the settlement.

Hunting for caribou, musk oxen or wolf may entail journeys over considerably distances and over wider varieties of terrain than would be encountered in journeys over regular traplines or to known fishing places.

Hunting whales, seals, walruses and polar bears necessitates considerable travel over sea ice, probably the least avoidable source of wear and tear on snowmobiles. This problem is accentuated in the spring when the machines must run directly on the ice and through the melt-water that has collected on the surface.

It is during the fall and the spring seasons that terrain conditions are at their worst. During the fall, the snow may be late, the cover discontinuous, and travellers may encounter considerable stretches of bare ground, rocky outcrops or vegetated surfaces. During the spring, such conditions reappear and are compounded by the increasing softness of the snow layer and the mud and moisture produced by the thaw.

On the sea ice during this season, hunters must contend not only with a surface of rough and broken ice mixed with slush and melt-water but also with the problems created by the break-up of the landfast ice. Travel at this season may entail jumping snowmobiles and sleds across open leads of up to 2.4 m (8 ft.) in width (this being given as the everyday maximum). This is one use for which the higher speeds are appreciated.

3.3. SOURCES OF OPERATIONAL STRESS

When asked about the typical kind of repair and replacement problems that might arise, even with the better designed multi-purpose machines, mechanics and dealers provided responses which fell roughly into three categories: (1) Problems arising from improper care and maintenance; (2) those referable to extreme operating conditions; and (3) those due to the machines being stressed beyond their limits, even well-maintained machines.

The majority of mechanics and dealers consulted were consistent in the view that, when a problem could not be traced to inherent weakness in design or materials, the primary cause of mechanical breakdown or malfunction would be improper care and maintenance by the owners. Frequent examples of such negligence were: the failure to warm engines sufficiently during very cold spells, inattention to the adjustments that should be regularly made to the tension on belts and tracks, failure to take the precautions necessary when travelling conditions were such that sliders would not receive sufficient lubrication, failure to notice or replace broken bogie springs. While making such comments, it was clear that dealers and mechanics had certain of their customers in mind and the remarks were invariably evidenced by references to specific cases where an identical part of model performed well when properly cared for.

From these discussions a distinction emerged between commonplace negligence (e.g. failure to warm engines sufficiently) and lack of a certain sensitivity to slight signals of performance falling off or parts moving out of adjustment. One mechanic felt that operators should be able to tell from the slight changes in engine sounds when the oil/gasoline ratio in oil injection systems was altering due to extreme cold (see subsection 4.2.3.).

Similarly, problems arising from changes in track tension, or alignment between tracks and sliders, should be detectable in the course of operating the snowmobile. Such problems as these were referable ultimately to individual interests and aptitudes. One mechanic, responsible for servicing a number of machines used by government employees, was confident that he could predict the problems that would arise from this person or that taking out a machine for a few days.

The second source of operating stress is one over which the user has little effective control. A major example of this is the effect that extremely low temperatures will have upon the materials used to fabricate snowmobiles. Also, however well-maintained a machine may be, to set it in motion at all when temperatures are in the area of minus 40° C is to induce stress beyond the levels that snowmobiles are built to withstand.

The third source of stress is one over which opinions differed about whether it was simply a version of one of the two above. Even the 'best' snow conditions north of the tree-line are more severe than those for which recreational snowmobiles are designed. Muller-Wille (1978) points out that the wind-packed snow surfaces typical of the Canadian tundra are substantially more damaging to snowmobiles than their counterparts in the Scandinavian Arctic. To these, normal, conditions may be added marginal conditions that will be encountered throughout the winter, but specifically during the fall and spring seasons: exposed surfaces of gravel, rock and vegetative mats, rough, bare, ice surfaces, melt-water and mud.

Opinions differed over the extent to which using a snowmobile in such conditions is simply an example of the first of the above categories - improper care and maintenance. Conversely, there was the view that, collectively, Arctic operating conditions conformed to the second category and, like the extreme cold, were facts of life that had to be lived with and their effects alleviated as far as possible. Thus, an owner would see little contradiction between maintaining his machine with great care but at the same time, when circumstances call for it, subjecting the machine to stresses well beyond those contemplated by designers. Thus, one trapper in the Mackenzie Delta, who had always relied upon the Bombardier utility model, the Elan, would use it to pull loads of 450 kg (1,000 lbs.) over hilly terrain, and would expect to replace the clutch several times throughout the winter; the trade-off was worth it to him.

It should be pointed out here that manufacturers do not advertise design limits, either with respect to tractive power, or the terrain conditions. On some models, it is stipulated that the warranty will not apply if a passenger is carried. Such a commitment to specific capabilities, such as tractive power, could place manufacturers in an equivocal position regarding warranty responsibilities. If, in recognition of the fact that Inuit regularly pull 450 kg (1,000 lbs.) with 340/440 models, the manufacturers were to advertise that as a performance feature, they would be required to support this by warranty commitments which could precipitate a rash of claims from southern users who might elect to try pulling such payloads around the countryside. On the other hand, if the towing capabilities implied in the stock sleds become the basis of an explicit commitment upon performance, and these are in the 100-150 kg (220-330 lbs.) range, then the implication would follow that those Inuit who elected to pull larger payloads would be automatically disqualified from warranty claims. The manufacturers with whom this was discussed expressed pleasure at the demonstrated tractive power of their snowmobiles, and expressed a willingness to install stronger hitches and reduce gear ratios so as to improve this further, but are understandably reluctant to make any specific claims about such capabilities.

A similar situation obtains with respect to snowmobile performance over 'marginal' terrains, such as the mosaic of bare, ridged, ice, slush and melt-water characteristic of the spring thaw. Such conditions are so pervasive, and their objective categorisation would be so complex, that an attempt to delimit performance capabilities with respect to terrain conditions would be counter-productive in its impracticability. In its absence, the only resort is to subjective assessment and this of course leads to frequent local dispute over the validity of warranty claims (see subsection 2.3.2.).

To some extent, such present problems are a product of the history of snowmobile development. Early models were widely perceived to be examples of all-terrain-vehicles (see Annex 1) and the comparative versitility of current bogie-suspended models provides a contrast with the recently evolved slider-suspensions, which undeniably provide greater speed and comfort but, on a more limited range of terrain types.

This question will be taken up again towards the end of section 4.6 - after a review of comments upon snowmobile performance under Arctic conditions. Before this, in the following two sections, an attempt will be made to estimate both the annual costs of snowmobile operation and the extent to which these may rise over the next 5 years.

3.4. LONGEVITY OF SNOWMOBILES IN THE ARCTIC

When asked how long a snowmobile lasted when used regularly for hunting, trapping and fishing, the common reply from Inuit users was one year. This would not necessarily mean that the machine would be totally unuseable after one such year; it would more often mean that, after a season of serious use, the probability of breakdown during the second year would rise to the point where a user would go to some lengths to obtain another machine. His machine of the previous year would not necessarily be scrapped; it may be retained as a spare, passed to another member of the family, restricted to local use, or sold in the community. When the means to buy a new vehicle are not available, the owner has little choice other than to overhaul the machine and replace critical parts.

The estimate of one year of serious and reliable use was not confined to those who use recreational models for utility purposes. Even the highly successful trappers from Sachs Harbour, who can afford to purchase Bombardier Alpines ($5,000) will obtain a fresh machine each year whenever possible. A breakdown on the trap-line may result in several days of trapping lost if a spare is not carried. The need to regularly attend to and adjust an old machine may mean spoiling the trap sets with traces of the smell of oil and grease. The Alpine is valued amongst Banks Island trappers for its capability in towing a payload of a ton, enabling the trappers to make longer runs or take larger complements of supplies, spare parts and fuel than that possible with the mid-size machines.

Owners, mechanics and dealers were frequently asked what kind of distance would be covered throughout a year of active use. Estimates given were surprisingly higher than the few, earlier, recorded examples. Usher (1972) estimated that the snowmobiles in use during the period, 1967-70, would last an average of 2 years and would cover about 1,600 km (1,000 mi.) during each year. Muller-Wille (1978) provided a slightly higher estimate for Repulse Bay in 1973: he estimated that snowmobiles would last for one year on an average and cover 2,500 km (1,562 mi.) during that period.

Both of these estimates were calculated from detailed information gathered over some time in both these settlements. For this survey, respondents were simply asked what kinds of distances they associated with 'serious' snowmobile use. Answers were provided with qualifications regarding condition, economic and environmental, but though they encompassed a wide range, 8,000 km (5,000 mi.) to as much as 16,000 km (10,000 mi.), they were invariably in excess of the estimates worked out for the earlier periods mentioned above.

There could be several reasons for such an increase. Snowmobiles have become faster and, perhaps more importantly, faster in more comfort. Those respondents who were grateful for the advance from bogie to slider suspensions, would point out that not only can current machines go faster but they can go faster for longer with less wear and tear upon the driver (see section 4.4.).

A further factor may be the difference in use. Usher (1972) estimated that in the period 1967-70, trappers would cover an average of 32.5 km (20.3 mi.) per day on the trapline. By comparison, it would not be unusual for a hunter in the eastern Arctic to travel 100-150 km (63-94 mi.) to and from a regular weekend hunting or fishing camp, and while there, he may put more mileage on his machine. While on such journeys, he may be exceeding the daily distance estimated above during each hour.

What is of perhaps greater significance than this estimated increase in annual distances covered is that, while his has happened, the life-spans of snowmobiles have not changed to any appreciable degree. These two studies revealed that snowmobiles during this period, 1967-73, would last one or two years; that is still the general case, but during these periods modern machines would cover appreciably greater distances than the older models.

Data from two other sources can be compared with the estimate of 8,000-16,000 km (5,000-10,000 mi.) as a crude estimate of the lifetime range of a modern snowmobile. The manufacturers abide by the estimate of longevity for recreational snowmobiles provided by ISIA, which is 8 years - and is based upon an analysis of snowmobile registrations in the United States. Asked what they considered to be the annual distance covered by recreational users, manufacturers replied in the range of 1,440-2,240 km (900-1,400 mi.). (Some manufacturers also observed that annual recreational mileage had increased considerably with the advent of the recent more comfortable, quieter and faster machines.) These estimates yielded a projected lifetime mileage for recreational use of 11,520-17,920 km (7,200-11,200 mi.).

Hydro-Quebec use Bombardier Alpine snowmobiles for monitoring lines across country. For this use, a machine will last two years, after which it is scrapped or retired for use around the depots. During these two years, the machines will be driven for an average total of 500 hours. Military tests of this model (L.E.T.E. 1964) yielded cross-country speeds of 5.6-8.4 km/h (9-13.5 mph.) which suggest that the distance likely to be covered during this 500 hours of cross-country work would be in the range of 7,200-10,800 km (4,500-6,750 mi.). (The military data was needed for these rough conversions because even Hydro-Quebec did not keep accurate records of distances covered.)

In the following section, an attempt will be made to estimate the costs of snowmobile operation and to provide a perspective upon how these costs are likely to change over the next five years.

3.5 SNOWMOBILE OPERATING COSTS: CURRENT AND PROJECTED TO 1986

The estimates presented in Tables 5, 6, 7 are based upon the following limits and assumptions:

Purchase Price: Three sizes of snowmobile are entered in the tables, with purchase prices reflecting those that Arctic buyers are faced with. Prices vary widely with the region and the dealer network. Those used here are conservative. The $1,700 refers to small machines such as the Bombardier Elan, the $3,300 refers to the mid-size dual purpose machines such as the Yamaha 340TF and the John Deere Arctic Trailfire Special, the $5,000 to the class occupied by the Bombardier Alpine. An annual price increase of 10% is assumed; again, conservative by comparison with increases in recent years.

Fuel Prices: At present, in NWT communities north of the tree-line, these range from a low of 53¢/litre (Repulse Bay) to a high of 75¢/litre (Pelly Bay). The average (including a new tax shortly to be imposed is 58¢/litre. The Petroleum Products Division of the NWT government expect that prices in the settlements will double by 1986. Therefore, for the purposes of this projection, this increase will be assumed according to the following increments:

1981/82	58¢/litre
1982/83	72¢/litre
1983/84	87¢/litre
1984/5	101¢/litre
1985/6	116¢/litre

Costs of Spares and Overhauls: The designation "spares" covers the parts that would be required over a season of operation without major mishap and includes items such as plugs, belts, minor structural replacement parts and possibly sliders. The costs for overhaul refer to the steps an owner would need to take in order to re-condition a machine for a second winter of use. The major item is the track (cost, $400-$500). Other possible components would include, new skis, suspension elements, engine overhaul. The costs for an overhaul at current rates are estimated at between $700 and $900. These are again conservative; many users estimate that the cost of re-fit is about half the price of a new machine. These are also projected to rise by 10% p.a.

Distances Covered Each Season: Costs are estimated for two distances. The minimum distance respondents gave for 'serious' use approximated 6,000 km (3,750 mi.). The maximum was in the range 12,000 km (7,500 mi.) - though a few respondents gave yet higher figures. (Though covering the longer distance would entail yet further expenditures on spares, this extra cost is ommitted for the sake of simplicity).

Fuel Efficiency: These are based upon estimates provided by users. For the small machines, 7 km/litre (20 mpg) was felt to be a good working estimate when pulling a load. Without a load, these machines may be considerably more fuel efficient. For mid-size machines 5 km/litre (14 mpg) while pulling full loads (respondents provided wider variations in their estimates for these machines, primarily, it seems, because there are more models and engine types involved). For the Bombardier Alpine 3 km/litre (8 mpg). Thus figure tallies with the estimates of Hydro-Quebec and the results of military test.

Table 5: SAMPLE OPERATING COSTS FOR A SMALL SNOWMOBILE

	81/82	82/83	83/84	84/85	85/86
First Year					
Purchase	1,700	1,870	2,057	2,263	2,490
Spares	200	220	242	266	293
Fuel/6,000 km	497	617	746	866	994
TOTAL	2,397	2,707	3,045	3,395	3,777
¢/km	0.40	0.45	0.51	0.57	0.63
Fuel/12,000 km	994	1,234	1,492	1,732	1,988
TOTAL	2,894	3,324	3,791	4,261	4,771
¢/km	0.24	0.28	0.32	0.36	0.40
Second Year					
Overhaul	700	770	847	932	1,025
Spares	200	220	242	266	292
Fuel/6,000 km	497	617	746	866	994
TOTAL	1,397	1,607	1,835	2,064	2,312
¢/km	0.23	0.27	0.31	0.34	0.38
Fuel/12,000 km	994	1,234	1,492	1,732	1,988
TOTAL	1,894	2,224	2,581	2,930	3,306
¢/km	0.16	0.18	0.21	0.24	0.27
2 yr total/ 12,000 km	3,794	4,314	4,880	5,459	6,089
¢/km	0.32	0.36	0.41	0.45	0.51
2 yr total/ 24,000 km	4,788	5,548	6,372	7,191	8,077
¢/km	0.20	0.23	0.27	0.30	0.34

Table 6: SAMPLE OPERATING COSTS FOR A MID-SIZE SNOWMOBILE

	81/82	82/83	83/84	84/85	85/86
First Year					
Purchase	3,300	3,630	3,993	4,392	4,831
Spares	250	275	302	337	365
Fuel/6,000 km	696	894	1,044	1,212	1,392
TOTAL	4,246	4,769	5,339	5,941	6,588
¢/km	0.71	0.79	0.89	0.99	1.10
Fuel/12,000 km	1,392	1,728	2,088	2,424	2,784
TOTAL	4,942	5,633	6,383	7,153	7,980
¢/km	0.41	0.47	0.53	0.60	0.66
Second Year					
Overhaul	800	880	976	1,047	1,181
Spares	250	275	302	337	365
Fuel/6,000 km	696	864	1,044	1,212	1,392
TOTAL	1,746	2,019	2,322	2,596	2,938
¢/km	0.29	0.34	0.39	0.43	0.49
Fuel/12,000 km	1,392	1,728	2,088	2,424	2,784
TOTAL	2,442	2,883	3,366	3,808	4,330
¢/km	0.20	0.24	0.28	0.32	0.36
2 yr total/ 12,000 km	5,992	6,788	7,661	8,537	9,526
¢/km	0.50	0.57	0.64	0.71	0.79
2 yr total/ 24,000 km	7,380	8,516	9,749	10,961	12,310
¢/km	0.31	0.35	0.41	0.46	0.51

Table 7: SAMPLE OPERATING COSTS FOR A LARGE SNOWMOBILE

	81/82	82/83	83/84	84/85	85/86
First Year					
Purchase	5,000	5,500	6,050	6,655	7,260
Spares	300	330	363	399	438
Fuel/6,000 km	1,160	1,440	1,740	2,020	2,320
TOTAL	6,460	7,270	8,153	9,074	10,018
$/km	1.08	1.21	1.36	1.51	1.67
Fuel/12,000 km	2,320	2,880	3,480	4,040	4,640
TOTAL	7,620	8,710	9,893	11,094	12,338
$/km	0.63	0.73	0.82	0.92	1.03
Second Year					
Overhaul	900	990	1,089	1,198	1,318
Spares	300	330	363	399	438
Fuel/6,000 km	1,160	1,440	1,740	2,020	2,320
TOTAL	2,260	2,760	3,192	3,617	4,076
$/km	0.39	0.46	0.53	0.60	0.68
Fuel/12,000 km	2,320	2,880	3,480	4,040	4,640
TOTAL	3,520	4,200	4,932	5,637	6,396
$/km	0.29	0.35	0.41	0.47	0.53
2 yr total/ 12,000 km	8,820	10,030	11,345	12,691	14,094
$/km	0.73	0.84	0.94	1.06	1.17
2 yr total/ 24,000 km	11,140	12,910	14,824	16,731	18,734
$/km	0.46	0.54	0.62	0.70	0.78

Estimates are developed for:

- total running costs for a single year of operation for, 6,000 and 12,000 km.
- running costs for an overhauled machine in the second year of its life, for 6,000 and 12,000 km.
- total costs for buying a machine, retaining it, overhauled, for a second year of operation.

The estimates are tabulated in Tables 5, 6, and 7. The cheapest case is running a $1700 machine for two years over a total of 24,000 km (16,000 mi.); total costs then amortize at 0.20¢/km (0.32¢/mi.). These costs are projected to increase to 0.34¢/km (54¢/mi.) by 1986.

However, these machines are not in general use north of the tree-line. A more common case would be a mid-size machine, scrapped after a single year of use. With 6,000 km (3,750 mi.) covered during that year, the cost would total $4,246 or 71¢/km ($1.14/mi.); with 12,000 km (7,500 mi.), the total cost would be $4,942 or 0.41¢/km (0.64¢/mi.). This latter figure is interesting in that many respondents would say simply that the current working figure for annual operating costs has now reached $5,000. The estimates made here show that this figure will rise to about $8,000 by 1985/86.

Comparable figures for operating the large snowmobiles over the longer distances are already approaching $8,000 for a single year of use and will exceed $12,000 by 1985/86.

4. SNOWMOBILES AS WORKING VEHICLES IN THE ARCTIC: COMMENTS UPON PERFORMANCE AND SCOPE FOR IMPROVEMENT

In this chapter, the comments that mechanics, dealers and users made upon the performance of snowmobiles, and their suggestions for improvements, will be presented in relation to the four major design elements of the snowmobile: power plant, transmission, suspension, body.

The comments recorded during the field work tended to be directed either at snowmobiles, or certain snowmobile features, in general, or at particular makes or models. Since the circumstances did not permit us to give equal weight to all, or a representative selection of, machines during controlled operating conditions (as in consumer product testing), this account will avoid categorical comparisons between the various makes - unless the comments have some useful general application.

Each group of design features will be treated in the following way. The function will be briefly described, evolution since the 1960's will be summarised, user comments will be presented, and, finally, the scope for improvements will be estimated, taking into account the constraints of production economics.

4.2. POWER PLANT

The following elements of the power plant will be discussed in turn:

- Engine
- Cooling systems
- Fuel supply & carburetors
- Electrical system - ignition
- Starter, manual, electric
- Engine mounting

4.2.1. Engines

With one three-cylinder exception, all snowmobiles are powered by single or twin cylinder two stroke engines, with displacements ranging from 246 cc to 635 cc. With the exception of Bombardier, all engines are of Japanese manufacture. Bombardier engines are built by an Austrian subsidiary, Rotax.

Engine development has been governed both by the desire to improve power to weight ratios and the need to conform to the noise legislation introduced during the early 1970's. In this development, four strok and rotary engines were introduced on some models but never became popular.

Noise control influenced the trend away from the louder single cylinder engines towards smaller twin cylinder motors. This trend entailed the sacrifice of some torque, thus reducing the pulling power of snowmobiles.

Mechanics and dealers interviewed in this study were virtually unanimous in their view that the major cause of engine failure was improper care by owners. Not warming engines sufficiently was cited as the most common fault. Over-heating as a consequence of pulling over-laden komatiks was also felt to be a frequent cause of breakdown. Frequently, it was said, owners would not run in their new engines properly.

When asked what power of engine was most suited for general working use, most users preferred the 340 engines (engines with displacements in the range 338 to 368 are usually prefered to "340's"). A smaller group of users preferred 440 engines (these encompass the range 432 cc to 462 cc in current production models). Generally, those who preferred the smaller engine sizes felt that the power balance with the larger engines was unsuitable for pulling, especially from a standstill, when the tracks would spin and the machine would dig into the snow. But it should be noted that, often, those who stated a preference for the larger engines made specific reference to models which happened to have relatively large track areas and would thus be less imbalanced in the sense mentioned above.

When questioned about future engine development, manufacturers were understandably unwilling to reveal their plans, but it seems safe to state that a primary factor will be increasing fuel efficiency.

The multi-purpose models recently introduced by Yamaha, Bombardier and John Deere all have 340 two cylinder engines. Next year, Bombardier will be offering a single cylinder 270 cc engine as an alternative in its Scandic model. The intention is to improve lugging power while reducing weight somewhat, and also reducing the price. Polaris will introduce a model aimed at the utility market; using a 440 engine de-tuned for fuel efficiency and geared down for pulling power.

4.2.2. Cooling systems

Three variations are in use: free air, fan-cooled, liquid cooled. At present, only one model, the John Deere Spitfire, is cooled by free air; the majority of the remainder are fan-cooled.

Free-air systems rely on the movement of the machine to create an air flow which is ducted over the engine. Fan-cooling simply employs a fan to produce the air flow, introducing a slight weight penalty and consumption of engine output. Liquid cooling permits engines to be pushed very hard but the weight, and cost, penalty is significantly higher than that for fan-cooling.

Early engines were usually cooled by free-air, but a demand for higher power and quieter engine noise led towards the introduction of liquid cooling. At this stage fan-cooled engines did not provide adequate noise reduction, partly because of poor design of cowlings and fans. Subsequent improvements in noise control technology have made fan-cooled engines more acceptable in this respect.

Users felt that fan-cooling provided a distinct advantage over the old free air systems, particularly when pulling loads at low speed, up hill, or when travelling through deep snow.

Though liquid cooling provided potential relief from such problems, most users felt that such advantages did not outweigh the added cost, weight and complexity of liquid cooling - and the extra horsepower produced was not required for pulling.

It can be concluded that current developments in the design of cooling systems work to the benefit of utility users. With increasing cost-consciousness amongst recreational users, improvements in the sound emission and efficiency of fan-cooling, it appears likely that, in future, liquid cooling will become increasingly reserved for only the very high performance machines.

4.2.3. Fuel supply and carburetors

Fuel tanks vary between 13.6 litres (3.0 gallons) and 30.7 litres (6.75 gallons). They are made out of plastic and moulded to conform to the shape of the vehicle. Most snowmobiles use a single carburetor, with the high performance types using two. All carburetors on current models are of Japanese manufacture.

Two systems are employed for mixing oil and gasoline. This is either pre-mixed by hand or mixed automatically by an oil injection system, which, besides accomplishing the mixture, is designed to improve performance by automatically adjusting the mixture ratio according to the performance of the engine.

There is evidence to show that the machines with oil injection use less oil than would be used when mixing oil and gas mixture (typically 50:1). However, one of the problems with current injection systems is that they are not easily recalibrated. Hence, for someone travelling a lot with their machine in different atmospheric conditions (high altitude) this can pose problems.

Fuel tanks and supply lines have become more durable and safer in the course of development. Carburetion has improved significantly, both in terms of fuel efficiency, smoothness of engine performance and ease of cold starting. Starting in very cold temperatures has been improved by the addition of primers. In the interests of reducing noise from carburetor air intake, air intake silencers have been developed which not only reduced noise but also improved performance and fuel economy.

The most significant design change has been the trend towards oil injection (75% of models in current production have this facility). For recreational use, or perhaps any form of use, this system has obvious practical advantages; drivers are relieved of the chore of mixing the fuels, carrying the separate containers necessary and trying to remember whether the oil is already in the gasoline or not. There is no question that this feature is a strong selling point for recreational vehicles.

But in regard to use in the Arctic, respondents tended to be equivocal. The major problem (apart from the approximately $75 cost penalty) is that at very low temperatures the oil would become too thick and could not be induced to mix with the fuel, with the result that the machines would be running on straight gasoline and the engines would seize.

This would start to happen as the temperatures fell below minus 20° C. Users would resolve it simply by reverting to pre-mixing and pouring the mixture directly into the fuel tank. But when there was still oil remaining in the oil injection reservoir, this would enter the fuel supply as the temperature rose, causing plugs to oil up. Some users simply remove the whole system.

The manufacturers responded to this problem by improving the design of the oil injection systems and by introducing oils that would be more miscible at low temperatures, (these are of course more expensive than regular oils). But still, many users do not feel inclined to trust oil injection systems, though, on the other hand, many do not feel there is any longer a real problem.

Discussions of the relative merits of oil injection and pre-mixing did not lead to any hard conclusions. It did seem, however, that, while for a recreational user an oil injection system may be a positive sales asset, Arctic utility users would not generally be turned away from a purchase simply because the machine did not possess oil injection.

Though oil injection is designed to improve performance as well as save labour, there was no indication from respondents that this was consistently perceptible enough to confer significant advantage over pre-mixing. All that can be said in conclusion is that, where lower costs, simple construction and operational security are at a premium, pre-mixed is superior; for labour-saving and perhaps a slight improvement in performance, oil injection is the better system.

The overall result of advances in fuel supply since the early days of snowmobile design has been to improve efficiency in consumption and operation and to improve the durability and safety of materials.

4.2.4. Electrical system: ignition

All current models employ capacitor discharge electronic ignition (CDI) systems, with the exception of the Bombardier Alpine and Elan, which retain contact breaker/magneto systems.

When the latter were common to all snowmobiles, ignition problems were among the more frequent frustrations visiting users, though these would be aggravated by problems with spark plugs, fuel mixture and the quality of wiring.

In current models, these have to a large extent been remedied, though when CDI was first introduced, the quality was generally poorer and breakdowns were more frequent than they are now. Users then experienced added frustrations due to the fact that such systems are less amenable to repair and adjustment on the trail than are breaker systems.

Mechanics and dealers on the whole felt that the reliability of CDI systems had improved to the point where their superior operational performance made them generally preferable to breaker systems.

4.2.5. Starters, manual, electric

About half the models currently in production rely upon manual starting only, most of the remainder offer both manual and electric while a few rely upon electric starting only.

Electric starting was widely regarded as inessential for utility use. It not only adds cost and complexity to the machines, but also suffers from battery problems in the extreme cold.

Users frequently complained about the quality of manual starter systems, particularly those containing synthetic materials. There is no doubt that, in the very cold periods, the bearing surfaces of manual starting mechanisms are subjected to more stress than in any other operating conditions.

In conclusion, though electrical starting systems may have improved during the late 1970's such systems as a whole are not required for utility usage. It should be pointed out that this conclusion applies to 340-440 utility machines; the Bombardier Alpine (635 cc) is in fact equipped with an electric only starting system. It appears that basically this is a marketing decision since most clients feel that on such a heavy machine the weight difference with electric start is not significant. However, there is no technical reason why it could not be offered manual only, apart from assembly line implications. The 640 engine is not that easy to crank; however, several years ago it was used in other model lines without electric start.

4.2.6. Engine mounting

With the exception of the Bombardier Elan and Alpine models, all snowmobile engines are now front-mounted, that is, they are placed over the skis rather than on the tunnel, which is the basic structural element of the snowmobile.

Only early snowmobiles, the engines were either tunnel mounted, just in front of the driver, or sometimes rear-mounted. Several factors influenced the gradual move forward and lower. Steering, especially on hardpack and prepared trails, became more positive due to the increased weight over the skis. Front-mounted engines can be more readily enclosed, making noise control more simple. Also, from the point of view of styling, a lower, front-mounted engine can be incorporated in a sleeker package than one mounted on the tunnel.

For travel on hardpack tundra snow surfaces, most respondents felt that the more positive steering provided by front mounted engines was a definite advantage, though an engine does not necessarily need to be low to the ground as well as far forward in order to achieve this effect. Users were less enthusiastic about low-mounted engines because of the increased likelihood of damage from impact while traversing uneven surfaces. Front-mounted engines are in addition easier to get at and work upon than those mounted on tunnels.

However, machines with front-mounted engines perform less agreeably in deep snow areas. One trapper, near Yellowknife described how he would lengthen the front struts so as to raise the hood above the skis. In such conditions, tunnel mounted engines confer a definite advantage.

Front mounting of the engine leads to an increase in cost of snowmobile construction since the attachment of the frame to the bottom plate must be redesigned to accept the additional stresses imposed by the engine mounting. The desire to produce a very sleek appearance further complicates the layout by requiring that the engine be mounted as low as possible. This results in a complex cross-member structure which joins the tunnel frame to the bottom plate and supports the engine mounting brackets. When aluminium is utilized instead of steel, the design and assembly become very sophisticated and it is rare for a new design not to encounter problems which require reinforcement the following year.

The advantages and disadvantages of this basic design change appear to come close to cancelling each other out. Certainly, for manufacturers to reverse this trend for utility snowmobiles, the advantages would have to be far more obvious than they are as such a change would entail considerable costs in re-tooling.

The disadvantages become more evident when deep snow operation is considered. There may be some scope here for developing a means of raising and lowering the front end as snow conditions vary. However, if the ski-legs were lengthened to provide a sort of "hydro foil" effect the problem would be the stress of the anchorages in the bottom plate since the effect of any impact on the skis would be significantly amplified by the longer moment arm.

4.2.7. Power plants: concluding remarks

Developments in engine efficiency have in general worked to the benefit of utility users, especially with respect to engine cooling, carburetion and ignition. Liquid-cooling and electric starting are redundant for utility use; oil injection, in its present stage of development has not yet proved to be consistently more reliable or efficient than pre-mixing. The forward displacement of power plants has proved to be acceptable for use on tundra snow; less so for use in deep, forest, snow.

4.3. TRANSMISSIONS

With the exception of the Bombardier Alpine (which has two forward gears and reverse) all snowmobiles utilise a variable drive system for transmissions of power to the track. The principle elements in this system will be discussed as follows:

Drive pulley (clutch), driven pulley, driven belt
Chain and chaincase
Drive axle and sprockets

4.3.1. Drive pulley (clutch), driven pulley, drive belt

Most snowmobiles utilize a form of automatic transmission or torque converter with a drive pulley or clutch linked to a driven pulley by a drive belt. This system is simple in concept, relatively light for the power transmitted, quite efficient and most flexible.

However, when applied to a snowmobile it must be carefully calibrated to suit the application. Consideration must be given to engine characteristics, the physical characteristics of the vehicle and the type of performance desired. Once this basic calibration is performed, usually in a laboratory using a computer controlled test bench which simulates the actual operation of the vehicle, further adjustment is usually required on the vehicle under field conditions.

As examples of how system calibration can be critical consider the example of the companies that attempted to calibrate with machines in summer running on grass. The difference in the drag of the skis on snow versus grass and the influence of cold weather versus warm weather on engine performance was sufficient to result in complete miscalibration of the systems. Some companies failed because of just such blunders.

The clutch reacts to engine output and RPM via a combination of spring tension and centrifugal weights. The clutch engagement RPM is a function of the spring calibration and for most snowmobile applications (racing excepted) the smoother the better. As RPM increases the centrifugal weights act to force the belt from its disengaged position at the heart of the clutch to the outermost position.

However, simultaneously the drive belt connects the clutch with the driven pulley. The driven reacts to torque from the engine but also the demard as imposed upon the track. At clutch engagement the drive belt will be at the heart of the clutch and the exterior of the driven. This is the equivalent of low gear. At speed, with the vehicle on a hard packed surface, the belt will move towards the exterior of the clutch sheaves and the heart of the driven pulley sheaves.

However, should the machine slowdown because it is about to leave the hardpacked surface or climb a hill, etc, the transmission must react instantly and smoothly to avoid loss of traction to adjust from a high speed low torque to a high torque low speed position. This is the instant when calibration is critical. More than one snowmobile company ceased to exist because their machines would become bogged down in soft snow and were hopeless in climbing hills covered with deep soft powder snow.

When properly designed and calibrated the system provides great flexibility and tractive power under all conditions, since it provides an infinite number of "gears" without a traction disrupting shifting action.

4.3.2. Chain and chaincase

The chain and chaincase transmit power from the driven pulley to the drive axle sprockets. The gear ratio is selected in order to best adapt engine characteristics to machine purpose, much like the final drive ratio in a car. Hence more emphasis can be placed on pulling power by gearing down the vehicle for a lower maximum speed but more torque or by selection of a gearing that favours maximum speed.

In most cases two-cycle snowmobile engines have good torque throughout the RPM band and fairly wide power curves. Hence, gearing can be quite flexible.

4.3.3. Drive axle and sprockets

The drive axle leads from the chaincase to the drive sprockets which transmit power to the track.

The drive sprockets mesh like a gear with the track. Various designs have been used however, in most vehicles today the sprocket teeth mesh with perforations in the track.

The smoothness with which this is accomplished and the "free-running" of the track under tension greatly influence the power loss in the drive system. Early machines tended to waste a great deal of power through friction losses.

Today vehicles use free-wheeling idler wheels to help relieve tension, improved materials result in less distortion of sprockets and track under stress. As a result tracks are quite free moving and most can be turned easily by hand while on the machine. This results in better overall performance and improved top speed for the same engine horsepower.

4.4. SUSPENSION SYSTEMS

Snowmobiles are suspended at two points: along the length of the track, at the skis. While ski suspensions systems are fairly conventional adaptations from automotive designs, the track suspension systems that have evolved over the years are more particular to the snowmobile and owe more to the peculiar demands of that vehicle than those from which the earlier suspensions were derived.

The primary elements of suspension systems will be reviewed in the following order:

- Front/ski suspension
- Rear/track suspension
- Track dimensions and types

4.4.1. Front/ski suspension

The suspension attached to most skis consists of a shock absorber combined with a single or multi leaf spring. A few of the high performance machines utlise coil springs, with or without shock absorbers, or telescopic strut suspensions.

The combination of a shock absorber and a leaf spring is common to all of the machines used, or advertised as working snowmobiles, and this had been so since the later 1960's. Advances have taken place more in the engineering, i.e. application and calibration of the shock absorbers to improve their effectiveness, rather than in the basic concept. In these respects, current ski suspensions perform far better than their predecessors.

4.4.2. Rear/track suspension

The great majority of current snowmobiles are equipped with slider suspensions systems; only the Bombardier Alpine and Elan models retain the bogie systems once common to all snowmobiles. Scorpion snowmobiles, which were taken out of production last year, employed a hybrid of the two types, the para-rail system.

While bogie wheel suspensions allow the track to conform closely to the contours of the terrain, sliders tend to keep the track straight and level, thus inducing a more intermittent contact. Bogies thus will provide more traction over rough surfaces, but at the same time subject the track itself to more deformation and wear.

Suspension travel with bogies is substantially less than that possible with slide suspensions. Slide suspensions will thus provide greater dampening at moderate to fast speeds over rough terrain, while, with bogies, as speeds pick up, the ride will become progressively more uncomfortable and more damaging to the machine.

Bogie suspensions are heavy, tough and cheap compared to slider systems; cheaper perhaps by a factor of five.

A major distinction between bogies and sliders rests on the fact that, to function properly, sliders require liquid lubrication between the sliders and the tracks, a lubrication which, under typical southern operating conditions is automatically provided by the snowmobiles passage over snow with average moisture content. Without this source of lubrication, the sliders are liable to heat up and eventually stick to the track. Bogie suspensions, on the other hand, do not require this lubrication and can be used over mud, sand and gravel surfaces without such problems - apart from the obvious one of increased track wear.

When sliders were first introduced to the extremely dry and cold operating conditions in the high Arctic, users often encountered problems with sliders over-heating, sometimes to the melting point. This problem was particularly evident during travel over bare ice. The most serious problem occurred with the plastic tracks, where the plastic slides were running right on the plastic track. One technique developed to cope with this problem was to insert a nail or spike in a position on the trailing edge of the ski from where it would cut into the ice surface and direct a spray of ice particles on to the track. Such a method was partially effective and became less so as ski stances progressively widened in relation to track widths.

One of the side issues about slide overheating relates to snow packing in the suspensions system. In the early seventies, manufacturers worked very hard to design suspensions that would eliminate snow packing. Snow packing would occur in deep wet snow when snow would collect inside the track and suspension system and pack solid reducing the effectiveness of the suspension system and freezing solid if left overnight. Hence manufacturers introduced small rubber tits on track interiors to break up snow. Idler and sprocket wheels were made with holes or cutting edges to chew up the snow. These measures worked very well. However, they also to some measure decreased the track's ability to be lubricated in marginal snow conditions.

Since then, the material used to fabricate the sliders has improved considerably and heating problems have been reduced, though not altogether eliminated. A feature which has been quite effective in dealing with the heating problem is the provision of extra, idler, wheels which can be attached to the suspension frame in such a way that they hold the track about 3 mm (1/8 in.) away from the sliders at the point where it passes over the rim. Such wheels are supplied in kits for attachment at prepared points. Many respondents were of the opinion that utility machines, especially the long tracked models should be produced with wheels already installed - as many as could be inserted along the length of the sliders.

In the mid-1970's, Scorpion introduced a suspension which suggested a compromise between bogie and slider systems, the pararail suspension. This system comprised a series of coordinated wheels attached to rails, with the tracks running along the wheel rims. Unfortunately Scorpion snowmobiles were not widely sold in the Arctic and none of the respondents to this survey was able to offer any comments upon the performance of this system compared to bogies and sliders. The system did perform will in cross-country endurances tests in the south. Unfortunately Scorpion snowmobiles have recently been withdrawn from production.

The general shift from bogie to slider suspension systems was, like that from breaker ignition to CDI, a development which at first was unsuitable for Arctic utility use but, with improvements has come to provide an acceptable level of performance.

However, in the views of some respondents, there has been a trade-off. The superior performance has been achieved in exchange for limiting the 'terrain versitility' of snowmobiles. There is, furthermore, a definite cost penalty attached to slider suspensions.

One very successful dealer thought that there would be scope for designing a complete bogie suspension unit which could be substituted for the slider suspension unit for use during the early fall and late spring. Such a unit, he felt would not necessarily cost much more than a new track and could be exchanged for the slider system with less than an hour's work.

4.4.3. Track dimensions and types

The track is as much a part of the power transmission system as of the suspension system; it is discussed in this section because of its physical proximity to the rear suspension.

A critical breakthrough in early snowmobile design engineering was the manufacture of an endless track; formerly, tracks had a joint where the ends were fastened and this constituted an inveterate weak point.

Three distinct track types have evolved over time. Rubber tracks, where the rubber is internally reinforced by metal or fibreglass crosslinks or rods embedded in the material. Cleated tracks, where rubber bands are reinforced and joined together by externally mounted metal cleat and bars riveted to the rubber. Plastic moulded tracks.

Plastic moulded tracks were introduced to reduce weight and wear yet maintain lateral stiffness without the necessity of internal or external reinforcing rods or cleats. While achieving comparative lightness, manufacturers did not succeed in economically overcoming problems of material stability and stress cracking, particularly at very low temperatures. A further problem with plastic tracks relates to the fact that the plastic is basically slippery on snow, as compared to rubber. Hence despite grooves and various profile designs, in some snow conditions these tracks had very poor traction.

Cleated tracks proved their worth in racing, largely because of the advantages they conferred in straight line acceleration. This advantage was most conspicuous when travelling forward on level ice but cleated tracks provided practically no lateral control, as was evident when machines passed over ice or icy surfaces with the slightest incline. Apart from these problems, cleated tracks proved to be less resistant, than rubber tracks, to damage from contact with the terrain; as a result, warranty costs to manufacturers became prohibitive.

Amongst snowmobile design elements, the behaviour of tracks under actual operating conditions was extremely difficult to model in advance and only after a considerable period of trial and error have rubber tracks emerged as the most practicable type. Though cleated, or semi-cleated, tracks are still available, and special inserts may be added to improve traction, rubber tracks are the present norm. In most cases these tracks will be internally reinforced, though sometimes the reinforcement may take the form of external, but recessed, grouser bars.

Respondents felt that track materials and design have improved since the mid-1970's, though users who travel regularly and drive throughout as long a season as possible expect a track to wear out in a year. Where travel can be confined to snow surfaces, wear will of course be reduced.

However, while advances in track design and materials have led to improved types for Arctic utility usage, a trend towards uniformity in track dimensions has been less welcome. Table 8 indicates the shape of this trend. In 1970, the manufacturers in total offered 15 variations in track width; of the 212 models then in production, 32% offered tracks in widths exceeding 43.5 cm (17 in.). By 1975, the number of variations in track width offered was almost halved, to a total of 8, and of the total number of models offered (115), only 20.5% provided tracks exceeding 43.5 cm (17 in.).

Over the last five years, the total number of variations in track width has declined to between 4 and 5, none of which exceed 43.5 cm (17 in.). In 1970, tracks produced varied between 26.9 cm (10.5 in.) and 58.9 cm (23 in.) (excluding twin track machines); by 1981, this range had shrunk to between 38.4 cm (15 in.) and 42.2 cm (15 in.). The large majority of tracks now produced are 38 cm (15 in.), or very close to it. This has been discovered to be the narrowest track width consistent with acceptable recreational performance on groomed trails.

The instability introduced by narrowing track widths has, to a considerable degree been compensated for by widening ski stances and lowering the centre of gravity of snowmobiles. As machines

Table 8: CHANGES IN TRACK WIDTHS OFFERED 1970-1981

track width		1970		1975		1977		1979		1981	
CM	IN	No.	%	No.	%	No.	%	No.	%	No.	%
29.6	10.5	1	0.5	-	-	-	-	-	-	-	-
30.72	12.0	4	1.5	-	-	-	-	-	-	-	-
37.12	14.5	-	-	4	3.5	-	-	-	-	-	-
38.4	15.0	74	35.0	48	42.0	27	64.0	31	82.0	33	77.0
39.04	15.25	23	10.0	-	-	-	-	-	-	-	-
39.4	15.38	-	-	-	-	-	-	-	-	2	4.65
39.7	15.5	34	16.0	31	26.0	4	9.5	-	-	2	4.65
40.3	15.75	10	5.0	-	-	-	-	-	-	-	-
40.96	16.0	-	-	5	4.0	3	7.0	2	5.5	2	4.5
42.2	16.5	-	-	5	4.0	4	9.5	4	10.0	4	9.0
43.5	17.0	11	5.0	9	8.0	3	7.0	1	2.5	-	-
44.8	17.5	6	3.0	-	-	-	-	-	-	-	-
46.1	18.0	31	15.0	10	9.0	1	3.0	-	-	-	-
47.4	18.5	10	0.5	-	-	-	-	-	-	-	-
48.6	19.0	6	3.0	-	-	-	-	-	-	-	-
51.2	20.0	6	3.0	-	-	-	-	-	-	-	-
52.5	20.5	2	1.0	4	3.5	-	-	-	-	-	-
56.3	22.0	2	1.0	-	-	-	-	-	-	-	-
58.9	23.0	1	0.5	-	-	-	-	-	-	-	-
TOTALS		212		115		42		38		43	

have become generally lighter, narrower tracks have been able to maintain similar degrees of flotation to those provided by the older, heavier, wider-tracked models. On snowmobile trails, where the snow is moderately well-packed flotation becomes even less of a problem.

However, many of the respondents in this study felt that wider tracks would be an improvement, even though hardpacked tundra snow is perhaps as supportive as the surface on groomed trails. This was particularly felt by those who at certain times travelled through the deeper and softer snow south of the tree-line. It would also be an advantage in pulling heavy loads. Several people pointed out that the engines installed in the larger machines could handle a larger track area; this would not only improve flotation but would also reduce the likelihood of such machines digging in while pulling - at the same time as more of the available power is applied in traction.

Manufacturers are aware of this problem, but, in enlarging the track area, the approach taken has been to lengthen tracks rather than widen them. This is understandable since lengthening tracks requires far less of an investment in production tooling than would widening them. The wide variation in the track lengths of current production models, in contrast to the lack of variation in widths, is evidence of this.

Exceptionally long tracks distinguish the recently introduced, or contemplated, series of multi-purpose machines. These snowmobiles have not been in general or long enough use for there to be firm opinions on how well they perform, but some users offered the view that there will be problems arising from the longer tracks drifting out of alignment with the slider suspension systems. Those who are familiar with the Yamaha Trapper (343 cm/134 in. track) and the Scandic (356 cm/139 in. track) have allowed that this alignment may need extra attention.

A further problem with long tracks is loss of contact while crossing uneven terrain. Slider suspensions maintain the level track profile to such an extent that the track moves from one peak to another. To counteract this tendency with long tracks, Arctic Cat developed a hinged rear track (see Photo 7) in designing the Long-Track Jag. This decreases longitudinal stress on the track while increasing the potential for maintaining contact. This hinged track, of really extraordinary length (155 in), seems to have met with the approval of utility users in Scandanavia.

One point in favour of long, thin, tracks is that less effort is required to break trail at the front end than would be needed for wider tracks. It remains to be seen whether this advantage is off-set by the disadvantages that may arise from such long tracks drifting out of alignment with sliders, not to mention the decrease in lateral stability associated with long, narrow tracks.

In discussing the question of widening tracks, some users pointed out that, with tracks substantially wider than 38 cm (15 in.) the internal rods embedded in rubber tracks may deform and not regain their former shape. This problem would be more critical with the comparatively flexible fibre-glass rods than with metal rods. It is a problem which the owners of wide-track machines have encountered in the past, particularly while driving on uneven or rock-strewn terrain.

For the 1982/83 season, Polaris plans to introduce an ultra-long tracked snowmobile with a hinged suspension - similar in principle to the Long-Track Jag (see Photos 7-8). This model will be called the SSTL. The track will be shorter than the Jag, 355 cm (148 in.) as opposed to 372 cm (155 in.). With a, de-tuned, 440 engine, it will be interesting to see how this power balance compared with that offered by the other mid-size utility type snowmobiles.

In conclusion it can be said that the advances that have occurred in snowmobile track material and construction have generally been as beneficial for Arctic utility use as they have been for southern recreational use. Changes in track dimensions have been dominated by a convergence in track widths, with the great majority of tracks now at 38 cm (15 in.). This trend has been subjected to the demands for recreational trail vehicles and the economics of production. Recently, manufacturers have been introducing variations aimed at the utility market; these have all consisted in lengthening rather than widening tracks. The superiority of this approach has yet to be confirmed as far as Canadian Arctic use is concerned, though the indications from Scandanavian Arctic use are that the very long-tracked machines perform satisfactorily as far as flotation and pulling are concerned.

4.5. BODY

The basic design configuration of the snowmobile had become well established by the late 1960's. Before, there had been variants: rear engines, articulated frames, enclosed cockpits, bicycle-like arrangements, and a few of these persisted into the 1970's. But, apart from the Bombardier Alpine (one ski/two tracks), all snowmobiles conform to a common body design.

The basic structural components of a snowmobile are, the tunnel or frame, supporting the driver and the rear suspension/track system, and the bottom plate, supporting the power plant, skis and steering mechanism. On the early machines, these components were built from steel; on current models, they are usually a combination of aluminium and steel (Bombardier Alpines and Elans and Yamaha Bravos are of steel).

The cabin, or engine enclosure, is usually made from fibreglass or polycarbonate. These components and materials do not stand up well under Arctic operating conditions, particularly the shields below the engine compartment. At various times, these shields have been made from plastic or fibreglass. This has always proved to be a disaster.

Snowmobile seats are a considerable improvement over early versions. They must now meet minimum energy absorbing criteria in order to prevent back injury, and have in fact come to be regarded as an element in the total suspension system of the snowmobile.

Seats are constructed from moulded foam and include a special insert of shock absorbing foam. As foam provides considerable scope for moulding and as seats are a highly visible part of the snowmobile, considerable attention as been paid to visually integrating them with individual model styling schemes while observing the safety requirements specified by legislation. This suggests that, if appearance were less important, more such attention could be re-directed to maximising the capacity of seating to insulate the driver from the shock of impacts on rough terrain. It is conceivable that such an approach might make travel with bogie systems more appealing from the point of view of physical comfort and health.

In conclusion, a certain kind of styling dominates the visual aspect of snowmobiles, which to a large degree inhibits the optimisation of design for utility usage. In this respect, it is instructuve to read the passages in snowmobiling magazines describing the new products, one of which alludes to the hitch on the Bombardier Nordik as being 'downright ugly'. Compare this perspective with one trend within the four-wheel driving world, where equally 'ugly' features such as winches and exposed suspensions are valued for the image of ruggedness and capability they convey to the onlooker. It is interesting to speculate what form of machine could evolve, within present production constraints, if design engineers were to temporarily suspend notions on what a snowmobile ought to look like in order to attract customers.

4.6 CONCLUDING REMARKS ON UTILITY VERSUS RECREATIONAL PERFORMANCE

In general terms, those design advances that have occurred since the late 1960's can be divided between those which benefitted recreational performance only, and those which improved performance for both recreational and utility use. Most 'advances' designed to improve utility use only were, as often as not, throw-backs to earlier features which had been superseded or unnecessarily sophisticated. Even though manufacturers now appear to be paying more attention to the needs of the utility user, this sector of the total market retains its 'poor relation' status, with any benefits derived incidental rather than deliberate. In this respect, the present intention of manufacturers to improve the fuel efficiency of snowmobiles is a direct response to the poor economic conditions prevailing over the whole of North America, not simply the fact of the high fuel prices common in the northern regions or the comparatively longer annual distances covered by utility users.

This said, the changes designed to improve the basic operating efficiency of engines, fuel supply, ignitions and transmissions have by and large benefitted both utility and recreational users. Engines deliver more power, more smoothly, in relation to displacement than they did ten years ago; they consume less fuel and start more readily. However, where power plants have been sophisticated for high performance, or the saving of labour, such changes have usually proved to be redundant from the point of view of the utility user. Major changes of this kind include, liquid cooling, electric starting and oil injection. These features add cost and weight without significant improvement of utility performance.

Changes that have taken place to the basic body of the snowmobile have been of two kinds: (1) material used, and (2) structural change to accommodate changes in power plant location. The increasing use of aluminium may have lightened total weight to a certain extent but it is doubtful whether such gains have offset the reduction in durability and the resistance to impact. All-steel bodies were generally not only stronger, but also more simple in construction; the use of aluminium increased the need for reinforcement brackets, etc. Moving the engines off the tunnel, the basic structural element of the snowmobile, and forward to a lower location between the ski struts may have improved steering control on tundra snow as well as on the surfaces of groomed trails, but it also introduced inherent complications and weaknesses into total snowmobile design by requiring that the power plant be mounted upon a body pan connected to the front of the tunnel. It may have been possible to achieve the effect of improving steering control by simply extending the tunnel further forward, but the demands of 'styling' called for lower, racier, profiles.

The improvements that have taken place in seat material and construction have certainly benefitted utility use as much as recreational use. This nas been not so much a question of improving the sheer comfort and 'ride' but of avoiding the positive danger to riders' backs presented by continual travel on the rudimentary seats of early snowmobiles. Minimum health standards now apply to snowmobile seat material and construction. When the seating is regarded as an element of the total vehicle suspension system, rather than a visual component in styling, there appears to be unexplored scope for cushioning riders from the shocks and discomfort of bogie suspensions in comparison to slider suspensions. This is an example of a design orientation that was not adopted by manufacturers because it was not aimed at the recreational market.

With regard to suspensions and tracks, sliders suspensions are used in all snowmobiles with the exception of the Bombardier Elan and Alpine, yet their overall superiority for intensive utility purposes has not been so firmly established. For example, there were no users of bogie machines who expressed dissatisfaction with this system, who stated that a change to sliders would improve these two models. Bogie systems are cheaper, tougher, and possess more terrain versatility than sliders; the major advantages of sliders are they are more comfortable and reduce the risk of injury to the riders, and that they are, in addition, more comfortable at speed. This difference underlines the incompatibility between utility use and speed to a greater extent than any other variation in basic snowmobile design. The general view of those who used both bogie and slider suspended machines was that bogie systems improved the pulling power of snowmobiles, by ensuring that a greater degree of track/terrain contact was continually maintained over the widest variety of surfaces. In this sense, bogies conserve the available power and contribute more to the overall fuel efficiency of snowmobiles. It is noteworthy that the one snowmobile model with which Inuit users were most familiar, and most regretful over its withdrawal from production, the Bombardier Olympique 300, was a bogie suspended machine (in its 340 manifestations, later Olympiques came with sliders).

4.7 A BRIEF REVIEW OF CURRENT AND PROJECTED UTILITY AND DUAL PURPOSE SNOWMOBILES

Table 9 combines four kinds of machine. Of the ten marked with an asterisk in Table 4, the Arctic Cat Panther has been excluded because, as things stand at present, this make will not reappear in 1982/83. The remaining nine have been combined with three new models projected for the next season: the single cylinder Bombardier Scandic, the Polaris SSTL and Gemini. (Unfortunately complete information on these new models is not yet available.)

The column 'track area' is simply computed from the length and width of the tracks. It provides a rough indication of the likely flotation characteristics in relation to the total weight of the machines. In computing actual bearing surfaces and ground pressure, other factors may be introduced: the area of the skis, the prospective weights of drivers and fuel, the actual proportion of the track which will be in contact with the terrain. As this last factor is reasonably constant (at 50%) the value of the figures presented here is retained as 'comparative indicators'.

Table 9: SALIENT FEATURES OF UTILITY AND MULTI-PURPOSE MODELS FOR 1982/83

Model Names S:small M:medium L:large	Displacement cc	No. Cyl.	Weight kgs	Starter (M) manual (E) electric	Ignition (C) CDI (B) breaker	No. Carbs.	Fuel Mix (I) injection (P) pre-mix	Cooling (F) fan	Ski Stance	Track			Suspension (B) bogie (S) slider
										length cm	width cm	area cm^2	
Bombardier													
S ELAN	250	1	285	M	B	1	P	F	25.5	292	38.4	11,206	B
M NORDIK	368	2	380	M	C	1	P	F	30.0	317	38.4	12,189	S
M SCANDIC	268	1	269	M	C	1	P	F	32.2	356	38.4	13,664	S
M SCANDIC	368	2	386	M	C	1	P	F	32.2	356	38.4	13,664	S
M EVEREST	497	2	458	M	C	1	P	F	33.5	317	42.2	13,377	S
L ALPINE	635	2	645	E	B	1	P	F	single	356	76.8	27,340	B
Yamaha													
S BRAVO	246	1	282	M	C	1	I	F	34.3	238	38.4	9,143	S
M 340	338	2	364	M	C	1	I	F	33.5	279	38.4	10,715	S
M 340TF	338	2	387	M	C	1	I	F	31.5	346	38.4	13,271	S
John Deere													
M TRAILFIRE SPECIAL	339	2	388	N/A	C	1	P	F	30.0	294	40.3	11,864	S
Polaris													
S GEMINI	250	1	N/A	M	C	1	P	F	N/A	294	38.4	11,289	S
M SSLT	440		N/A	M	C	1	P	F	N/A	379	38.4	14,548	S

Of the twelve machines listed, three are annotated as 'small' and one as 'large', the twin-track single-ski Bombardier Alpine. The remaining eight loosely conform to the mid-size in wide use in the Arctic as a working machine. (It should be noted that manufacturers do not as a rule refer outright to these models as 'working' or 'utility' models, but rather as 'dual-purpose' or 'multi-purpose' presumably so as not to lose the attention of recreational purchasers.)

The mid-sized models have certain features in common, particularly those aimed directly at the utility market. Yamaha is represented by the 340 TF 'Trapper' model. With its long track, comparatively 'no-frills' design, and sturdy construction, this has been welcomed as a working machine, more so, it seems, in communities along the tree-line than those located on the tundra. In these regions, the shorter-tracked 340 models have often proved to be more popular.

For the same market, John Deere has developed the Trailfire Special, a model which rarely appears on its roster in the south. This is a 340 machine, largely a modified, or toughened version of the regular 340 Trailfire. The oil injection system has been removed, extra wheels have been added as standard items, a primer and an enlarged windshield.

Bombardier is represented by three machines in this sector. The Nordik is not so much a modification of a current model, as an assemblage of various features from other models: the skis from the Blizzard, the track from the Everest (in length at least), the frame from the Citation. The Scandic is distinguished from the Nordik only by its extra length of track (from the Alpine). For 1982/83, the company plans a more simple version of the Scandic, offering a single cylinder 268 cc engine (from the Citation 3500) geared down to increase lugging power. With this machine, Bombardier will come close to resembling the old, and popular Olympique 300 (except for the suspension). The machine is designed to achieve similar top speeds to the twin-cylinder Scandic but at a lower rate of acceleration. The comparative success of these two models should indicate the relative premiums placed by users on pulling power versus speed.

The Bombardier Everest is included here because so many dealers and users reported on its popularity as a powerful pulling machine. The model has been produced for long enough for users to become thoroughly familiar with it. The engine is large, at 497 cc, but so is the track - the only wide-track persisting amongst machines that are put to working use.

In terms of design, perhaps the most significant departure amongst machines for the next season, will be the Polaris SSTL. This is a somewhat substantial modification of the Cutlass SS440 (see Table 4). The oil injection system and the electric option have been removed, the 440 engine de-tuned to increase fuel efficiency and the transmission geared down to increase low-speed torque. The most significant modification has been the increase in track length from 279 cm (115 in.) to 355 cm (148 in.). This extension incorporates a hinged rear suspension element, similar to that introduced on the Arctic Cat Long-Track Jag (see Photo 7). This feature has been introduced primarily on the recommendation of Scandanavian users who find that hinging improves the performance of ultra-long tracks.

The small machines will be represented by three models. Of these, the Elan has proved its worth as a utility machine over a long period. At various times, Bombardier have attempted to introduce variations, slider suspensions, 440 engines, and at one point it was decided to withdraw the model altogether from production; the reaction to dealers to all these attempts was immediate and determined enough to convince the company to retain the basic design. The Yamaha Bravo is competitive in terms of price and economy of operation but does not yet appear to have demonstrated a tractive power equivalent to the Elan. In terms of design, the re-introducted Polaris Gemini will offer competition more directly to the Bravo than the Elan.

In conclusion, the machines due to appear as offerings to the dual-purpose market for mid-sized snowmobiles will by and large possess power plants and trains suitable for utility usage: geared down or de-tuned 34-/440 engines, fan-cooled, pre-mixed lubrication, and manual starting. With regard to basic structure and bodywork there seems to be scope for improving material and basic design, even though this might entail both a weight penalty and loss of sleekness in profile. Finally, it is arguable that the case for slide suspensions over bogiew rests upon the attention that has been devoted to improving the former while improving the latter has been largely ceased to be a design priority once the general committment to slide suspensions was made.

5. CONCLUDING CHAPTER

> "There are three reasons why your project won't produce the ideal snowmobile:
>
> 1) The manufacturers won't do it because they will go out of business, after which I shall go out of business.
>
> 2) It will be to heavy for proper flotation.
>
> 3) However strong it was, some of my customers would manage to break it."
>
> Willie Emudluk, George River, Sept, 1981, Interp. Jean-Guy St Aubin .

5.1. INTRODUCTION

To return to the demand, "a more rugged snowmobile at half the price", this survey has shown that the solution to this problem, though it has design engineering aspects, is overwhelmingly economic; more precisely, rooted in the economics of production and distribution (a snowmobile leaving the factory usually costs less than half the price).

Below, is a summary list of the elements of which the 'snowmobile problem' appears to be compounded. These are not listed necessarily in order of importance, but they can be assigned to three general groups, under which they will be discussed in the remainder of this chapter, These are: economic, technical, operational.

- Increasing costs of new machines and spare parts.
- Increasing fuel costs.
- Irregularity in supply of spares parts.
- Shortage of repair facilities.
- Recreational design orientation of snowmobiles.
- Extreme operating conditions.
- Improper care and maintenance.
- Incompatibility between speed and durability.

5.2. ECONOMIC ASPECTS OF THE PROBLEM

Estimates of the total size of the snowmobile market north of the tree-line were in the range 1,500 - 1,600 p.a., about 1% of the total snowmobile market. It was beyond the scope of this study to attempt to estimate the total 'utility market' but, in the view of ISIA officials, it would not exceed 10,000 for North America (about 7% of the total market).

Though small, the utility market appears to be reasonably stable when compared with the recreational market - which continues a decade-long decline, relieved only by a slight upswing in the late 1970's.

Manufacturers have responded to this relative stability by, in recent years, paying more attention to the specific needs of utility users, many of them in the Arctic. But while this may result in the production of machines more appropriate for Arctic use, such machines will not necessarily be any cheaper than their recreational counterparts. In fact, the reverse appears to be the case, with the recently introduced "dual-purpose" models tending to cost somewhat more than the recreational versions from which their designs were derived.

The two 'old-fashioned' utility snowmobiles which have remained, substantially unchanged, in production for over ten years, cannot be said to be distinguished from other machines by significantly lower prices or operating costs. The absence of 'redundant' recreational design features from these models does not seem to have depreciated their costs in any substantial way.

Conservative estimates of the rates at which costs may be expected to change between 1981 and 1986, do not hold any promise of relief from heavy annual costs for those who use snowmobiles regularly for hunting trapping and fishing.The principle cost component is the purchase of a new machine: the survey revealed that many, perhaps most, users discard a snowmobile after one year, and that very few will retain their machines after two years of regular use.

By comparison with southern recreational users, Inuit are penalized twice. The shipping costs are such that machines will cost $400-600 more to buy in the Arctic and these costs will be amortized over only one or two years. The average longevity in the south is 8 years.

Some manufacturers have now declared an intention to focus on increased fuel-efficiency in future developments. This is largely a response to the southern market and while Arctic users will clearly benefit to some degree, the total relief from decreased fuel costs would be slight compared with that which might be acheived by lengthening the working life-spans of snowmobiles.

Snowmobile manufacturers consulted during this study expressed the view that the total market will at some point level off at a volume which will enable an accurate appraisal to be made of the relative importance of the utility market. It was expected that this would take place during the present season, with its ideal snow conditions - after two poor snow seasons. This has not happened and, as figure 1 shows, the decline is continuing.

5.3. DESIGN/ENGINEERING ASPECTS OF THE PROBLEM

Since the basic design configuration of the snowmobile became established over ten years ago, subsequent development has certainly been dominated by improvement of the machines as recreational rather than utility vehicles. But, though benefits for utility use have been incidental to this development, they have still, in certain respects, been substantial. Both power plants and transmissions operate more reliably and efficiently than those of ten years ago. Similarly, advances in track and belt materials have improved both utility and recreational performance.

However, these advances have been accompanied by a certain convergence in design, with buyers now being offered fewer variations upon the basic configuration than they were ten years ago. This is especially apparent with respect to the width of snowmobile tracks. A consistent view of respondents in this survey was that the present norm, 38 cm. (15 in.) is too narrow for Arctic use. Others felt that the structural complexity introduced to support low-slung forward mounted engines reduced the capability of snowmobiles to withstand the impact resulting from operating over Arctic terrain.

Thus, the advances that have occurred over the last decade have been both advantageous and disadvantageous for Arctic utility use. The benefits have been incidental to research and development for recreational performance, which has meant that certain research orientations, which could have directly improved utility performance may have been neglected. The general transition from bogie to slide suspension systems is the primary example of this. While appreciating the improved performance of slide suspensions in certain conditions, and the reduced risk of back injury and fatigue, some respondents were equivocal over the reduced terrain versitility introduced by this form of suspension. However, once the general transition from bogies to sliders had been accomplished, little thought seems to have been directed towards the possibility of improving the riding characteristics of bogie systems whilst retaining their superior terrain versitility.

All surviving manufacturers have recently, or will shortly, introduce "dual-purpose" models which, though modified versions of recreational machines, are aimed at the Arctic utility market - amongst others. These machines have been available for only one or two years, and though this is not long enough to establish their comparative durability, in terms of utility performance, they have generally been well-received.

These machines share certain characteristics. They have longer tracks for improved flotation. They may be heavier than their recreational counterparts, though equipped with fewer of the more sophisticated accessories that have emerged over the last decade. They may have single-cylinder or de-tuned twin-cylinder engines and geared down transmissions. Other features, such as primers and high windshields improve their applicability for Arctic uses. However, though these models are simpler than the recreational versions, they are no cheaper.

5.4. OPERATIONAL ASPECTS OF THE PROBLEM

Though snowmobile dealers and mechanics stressed that improper care and maintenance were frequent causes of breakdown, the consequences of such negligence should be distinguished from the results of using well-maintained machines in typical Arctic operating conditions. Even the trappers of Banks Island, who have a high reputation for professionalism and mechanical competence in their approach to resource harvesting, and who prefer to depend upon the most expensive of the utility machines available, also prefer to obtain a new machine each year. There,a machine that is one or two years old may only be regarded as suitable for use in and around the settlement.

This begs the question of how practicable an objective it would be tc embark upon an R&D program designed to develope an improved version of the snowmobile if the toughest and most expensive machine on the market can only provide a single season of acceptably reliable use?

While there may be compelling reasons to believe that the factor contributing most to snowmobile wear and tear is high speed travel, it should be remembered that trapping, in itself, does not entail high speeds: in fact, the Bombardier Alpine is barely capable of reaching 45 km/h (28 mph) (LETE 1969) with a load of 102 kg (225 lbs.).

5.6. THE SCOPE FOR IMPROVING THE SNOWMOBILE THROUGH AN R&D PROGRAM

It was pointed out above that the major source of the 'snowmobile problem' rests in the economics of production. The manufacturers know how to build stronger snowmobiles, but, with good reason, they believe that the utility market would not be prepared to bear the increased costs of such vehicles.

As described in Chapter 2, most manufacturers have also made attempts in recent years to discover what kinds of alteration in design would improve snowmobiles for Arctic utility use. Those changes that proved to be economically feasible were incorporated in the dual-purpose models which are in current production; those which were unfeasible were left out. Wider tracks are the most obvious example of the latter. In this study, users consistently expressed the view that the 38 cm (15 in.) tracks are too narrow and that an increase of one or two inches would be an improvement. When this view was conveyed to the manufacturers, the invariable reply was that the re-tooling that would be required to widen the tunnel, in order to accomodate a wider track, would not be justified by the size of the market.

This suggests that a suitable subject for research might be not so much the basic design or performance of snowmobile but the means by which small quantities of machines may be produced economically, in perhaps a modular process facilitating the overhaul or replacement of major components.

A further area of research may be loosely defined by the directions which were not taken in the course of sophisticating snowmobiles for recreational use. As pointed out in section 5.5., the change from bogie to slide suspensions is a major example of this; subsequent improvment of bogie systems became a redundant excercise once the transition had been accomplished. Yet there may be scope for improving bogie systems in such a way that their terrain versitility is conserved while the rider fatigue and risk to back injury associated with this suspension type is reduced to acceptable levels.

A similar example of a development which was directed at the recreational market at the expense of the utility market was the transition from tunnel mounted power plants to front-mounted units. This led to a weakening of the overall structural integrity of snowmobiles even though it may also have improved the steering performance on hard snow. It is conceivable that this improvement in steering could have been accomplished by extending the tunnel further forward; instead, engine mountings were lowered to levels below those supportable by the tunnel. This was done primarily in the interests of styling, of providing for a low-slung look to the machines. In this respect, it may be noted that a snowmobile assembled entirely around a tunnel, as they once were, would both facilitate a modular approach to design and simplify the production process.

5.7. OUTLINE SPECIFICATIONS FOR A MID-SIZE MODULAR UTILITY SNOWMOBILE

5.7.1. General Objectives

In this final subsection, the results of the field study are combined with design and production engineering possibilities to to generate a set of outline specifications for a utility snowmobile that would be built by a modular or unitary assembly process. Such an approach would offer the possibilities of both reducing initial tooling investment and of facilitating the overhaul of machines after periods of intensive use. In principle, it resembles the modular assembly process developed by the Ford Motor Company for the production of cheap utility vehicles for developing countries.

In a sense, the production process and design suggested here marks a reversion to snowmobiles as they were in the mid-1960's. However, that simplicity of construction is combined with the advances that have been made in technology and materials; advances, it should be pointed out, that were in part made possible by the enormous popularity of snowmobiles as recreational vehicles.

The principle capabilities of this machine are:

1. Tractive capacity 450 kg (1,000 lb.).
2. It should be effective in marginal snow/ice/terrain.
3. It should have a top speed of 72 km/h(45 mph)
4. Modular design for ease of assembly and repair
5. It should be capable of accepting tracks of varying widths.
6. The gearing should be easily alterable to increase tractive power while decreasing top speed.

5.7.2. Power Plant

The engine would be a single-cylinder two-stroke of about 18 hp. Such engines possess a wide power curve and the resulting good torque through the range would optimise pulling power. Advances in engine and cabin design would be applied to reducing noise levels to below those associated with early single-cylinder engines. The engine would be fan-cooled, the fuel pre-mixed and the manual starting system would be reinforced over those in current production. The power plant would be mounted on the tunnel, which would be extended to place the weight over the skis and maintain the steering advantages conferred by front-mounted engines.

5.7.3. Transmission

The basic design would resemble those in current use. But with a top speed of 72 km/h (45 mph) or less, a reduced demand would be placed upon the transmission and more attention could be paid to optimise durability, pulling power and ease of maintenance. With only 18 hp., some components could be simplified, with resulting cost savings.

A range of gearing could be provided, with users offered the option of increasing pulling power, at the cost of reducing top speed. Reduced gearing could also be offered to compensate for a selection of wider tracks. Consideration could be given to adding a reverse gear.

5.7.4. Suspension

The principle suspension would be bogies, but the modular approach would enable sliders to be readily exchanged as an option. The lower speeds may make the riding characteristics of bogies more tolerable;

however, attention would be directed towards improving the seating, as an element in the suspension system, as a means of resolving this problem (see 5.7.5.)

A careful investigation would also be made of the para-rail and para-slide systems developed by Scorpion to discover to what extent they may increase terrain versitility over sliders while preserving riding characteristics.

Tracks would be selected for wear rather than performance. With reduced power to transmit, and reduced top speeds, sprockets, axles and other components could be simplified and built for durability rather than performance.

5.7.5. Frame and Body

The basic structural element, the tunnel, will support the power plant, as it did on most early snowmobiles. Steel would be used throughout. The possibility would be investigated of constructing the cabin from sheet steel. This would result in a more simple, but more durable shape than that found of current models. The frame would be capable of accepting track widths varying between 38 cm (15 in.) and 45 cm (18 in.).

Other possibilities to be investigated would be:

1. A narrower skis stance, but with wider skis.
2. A metal fuel tank, detachable like that of an outboard motor.
3. Cheap automotive lighting instead of stylized components.
4. Improved seat design and materials.

5.7.6. Recomendations on the modular snowmobile approach.

A machine such as that oulined above would be slow and ugly according to the standards represented by current models. To gain acceptance, it would probably have to offer significant improvements, both in utility performance and costs of aquisition and operation. It is conceivable that such a snowmobile, if produced, would take several years to establish a reputation - especially for durability: 8-10 would not be an unreasonable estimate for the total time that might be needed for, feasibility studies, prototype construction and testing, production, and, finally, demonstration of capabilities through use over several seasons.

Such a time-span may seem exaggerated compared with how long it might take an established manufacturer to design, produce and prove a new recreational snowmobile. However, it is proposed in the belief that such a development project would ultimately only succeed if executed through a collaboration between the required design and production engineers and an appropriate Inuit organisation, or group of such organisations. Such a group would be best-placed to assume responsibility for acting at the interface between technologists and snowmobile users. If is felt that such a necessary collaboration would inevitably lengthen the process of design/production/proving such a machine, but this should not be regarded as a drawback.

The first step in such a process would be to establish the technical and economic feasibility of a modular utility snowmobile and compare the costs and performance with those provided by available dual-purpose snowmobiles.

5.7.7. A Suggested Process for Implementing these Recommendations.

The following steps are suggested as a means of implementing these recommendations:

1. That the Inuit Development Corporation assumes responsibility for coordinating a feasibility study organised as a collaboration between design/production engineers and an invited group of regular Inuit snowmobile users.

2. That, if feasibility is established, the study is completed by a prototype design and production plan which can be put into action immediately.

3. In this plan, particular attention should be addressed to transfering as much of the assembly process to northern communities as is viable given the constraints of small volume manufacturing.

4. This plan should be developed through an iterative process, using as a starting point the "outline specifications for a mid-size modular snowmobile given in subsection 5.7. A first approximation of the plan may be based upon these specifications and then submitted for review by the group of Inuit users.

5. To expedite this iterative process, the potential offered by employing an interactive computer-based graphic design program should be investigated. Such a program would illustrate the critical trade-offs and design alternatives, together with the constraining effects of costs, in such a way as to engage the participation of the Inuit review group in a hands-on situation.

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ANNEX 1

THREE-(OR MORE)-WHEELERS

ANNEX 1 - THREE-WHEELERS

At one time, the popular image of the snowmobile was that of an all-terrain vehicle (ATV). In theory it was, but in practice it became progressively less so as it gradually became more specialised, first for travel on snow only, then for travel on groomed snowmobile trails.

The identification of snowmobiles with ATV's was not the intention of their primary inventor; Bombardier had always been interested principally in a light vehicle for travel over snow. Nevertheless, it is ironic, in view of the emerging conflict between three-wheelers and snowmobiles over the use of groomed trails, to recall that both these vehicles once shared the same sort of magazine space.

The extracts inserted in this annex were all taken from what were ostensibly snowmobile magazines, published about ten years ago. Snowmobiles soon emerged as the most popular vehicle and the other types of ATV faded from view. Perhaps these off-road vehicles, which could not be driven on highways, were unable to compete with the jeep type of vehicles which could legally operate both on and off roads.

In any event, three-wheelers have emphatically returned. Sales in the United States rose from 80,000 in 1979 to 100,000 in 1980; at such a rate, they will soon eclipse the sales of snowmobiles. Not only is their terrain versitility superior to that of a snowmobile, but they also offer advantages over two-wheeled ATV's:

"The upright attitude when parked combined with the capability to take a small load almost anywhere make these vehicles an ideal 'mini-tractor' and/or a general farm and ranch utility vehicle. These same advantages are also important to hunters and other outdoor recreationists" (The Recreational Trailbike Planner Vol II, No 3, quoted in ISIA 1981).

Three-wheelers have also become increasingly popular in the Arctic, in fact, they are often called "tundra bikes". At present, they are used mainly for travel around the settlement, in summer more than winter, but their potential for travel over snow has been recognised, if not as intensively exploited as it might be.

Three mass producers dominate the three-wheeler market: Honda, Yamaha, Kawasaki. Engines range up to 250 cc in displacement, prices to around $2,000. Some of the larger models can be equipped with racks and trailer hitches. Hunters from Coral Harbour have built racks on three-wheelers and used them during summer caribou hunts on Coat's Island to collect the caribou and take them to their peterhead boats.

A much wider range of vehicle types (including four-wheelers) is put out by the established agricultural equipment producer Carl Heald. This company produces its machine in kit form, for assembly over a day or so. The most substantial three-wheelers have a total payload of 364 kg (800 lbs.) and, according to the manufacturer,are capable of pulling a similar load.

The ATV's described and depicted in the accompanying extracts may appear to be too specialised, or outlandish in some ways, but it cannot be denied that the three-wheelers that have recently risen to such popularity are essentially derived from this class of vehicle. Their limited but successful use over hard-packed tundra snow suggests that low-pressure tires could in principle provide competition to snowmobile tracks. But this principle is presently being developed in order to exploit the southern recreational market rather than to meet the needs of Arctic utility users.

SUMMER'S SNOWMOBILE...

WINTERTIME'S BIKE

Tri-Sport

YEAR-ROUND BIG SELLER!

The three wheeler market is undoubtedly the fastest growing segment of the red-hot Recreational Vehicle business. And Tri-Sport is the undisputed sales leader in the three wheel industry.

Three Wheelers Make Sense For Dealers

Just because the seasons change is no reason why you should have to change your way of doing business. With its optional front ski, Tri-Sport's in business all year long.

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The margin's there. And most dealers get full list, because Tri-Sport's priced right — from $345, F.O.B. Norwalk, Ohio. Tri-Sports move quickly. You can expect to turn inventory around quickly, ready to holler "re-order" in days.

Most businessmen like you already qualify for the Tri-Sport line. All it takes is a location with land available for demonstrations and a modest cash investment for inventory. In most areas, stock will come from distributor warehouses nearby, you'll be in business in just a few days.

Sound Good?

You bet. Why not send us the coupon and we'll get someone to you right away with all the details.

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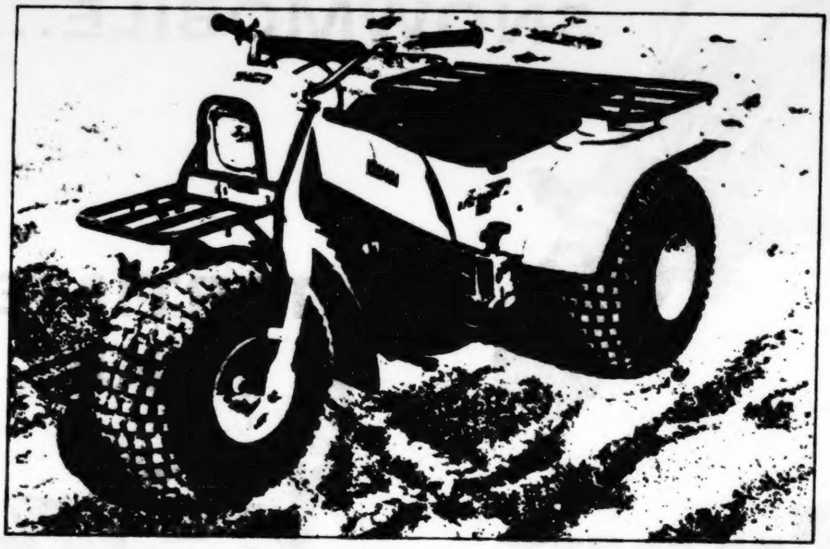
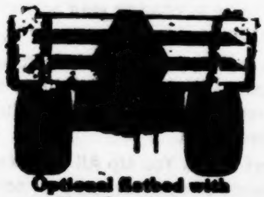


Regular dump box, standard.

Optional flatbed.



Optional flatbed with optional seats to use

THINKING ABOUT BUYING A SNOWMOBILE?

WHAT IF IT DOESN'T SNOW?

— REMEMBER LAST YEAR?

WE HAVE THE ANSWER — THE

NO RISK SNOWMOBILE

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WHEN YOU PURCHASE AN 'ARGO' YOU WILL JOIN THE MANY WHO HAVE ALREADY REALIZED THE WHOLE NEW CONCEPT IN OUTDOOR FUN. & EXCITEMENT THAT THE ATV HAS TO OFFER.

LETS COMPARE AN ARGO TO A SNOWMOBILE

	ARGO	SNOWMOBILE
USES	LAND WATER WINTER SUMMER SPRING FALL SNOW ICE MUD	SNOW
SPEED	0-45 mph Land 0-5 mph Water 0-40 mph Snow	0-60 Average
COST BASED ON DAYS OF POSSIBLE USE PER YEAR	$4.44 per day 365 days $1595.00 (400 cc engine)	$40.00 per day Approx. 30 days $1200.00 (400 cc engine)
CAPACITY	Carries 4 adults	Carries 2 adults

We think you are beginning to get the picture, that's why the Argo "The No Risk Snowmobile".
Come in for a test ride & demonstration.

ONTARIO DRIVE AND GEAR LIMITED
Box 280 Bleams Road
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TERRA JET

The "New Sport" Vehicle

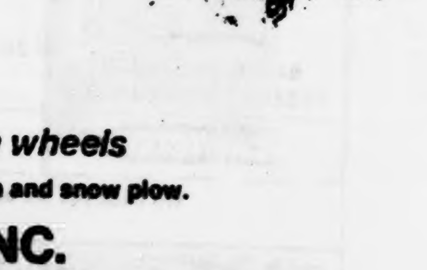
The 1971 TERRA JET, with sports car styling and molded fibreglass body, is proving to be the most popular all-terrain vehicle manufactured. It has a sturdy steel chassis; a powerful 28 horsepower electric start engine; four-wheel drive; forward, neutral and reverse transmission; bucket seats; and is completely amphibious.

The most RELIABLE machine of its kind

Designed and manufactured in Canada, this all-season sports vehicle looks, drives and handles like a "muscle car". Goes over rocky terrain that would stop conventional ATV's in their tracks. A roll bar, extra wide tires, flexible windshield and strong bumper provide additional protection.

It has the looks... and OFFERS top performance

With a carrying capacity of 1000 pounds, TERRA JET easily handles three people. It is capable of land speeds up to 50 mph and cruises over water at 5 to 7 mph. Takes heavy snow in its stride and glides through marshes, sand and muddy areas without hesitation. Durability and stability make this one of the finest ATV's manufactured.



The SAFEST sport on wheels

Accessories include convertible top and snow plow.

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P.O. Box 724 — Trans Canada Highway
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For further information circle coupon No. 2

The Canadian All Terrain Vehicle Manufacturers' Association was formed last year, bringing together the 10 major Canadian manufacturers of ATV's for the purpose of standards, safety and promotion.

Among the different functions of the Association are such things as assisting dealers with problems, setting up and running rallies for ATV promotions in local areas and, above all, engaging in the creation of component and design standards including safety features and promotion of safe useage of ATV's.

Other Association interests range through important topics such as conservation, pollution (including noise pollution from vehicles), legislation affecting ATV's, better warranty for dealers and owners, even opening up new areas for promotion of the "go-anywhere" vehicles.

"We are determined to learn from the mistakes of the snowmobile people," president John Fagan told Canadian Sno-Mobiles. "We want to create our own standards before we have standards shoved down our throat, by government, for instance. We, as individual company members, are often not rich enough to advertise nationally, so we can tell the ATV story nationally as a group. We all benefit."

Good communications is obvious between members. These progressive programs should assure the ATV market in Canada of good quality, service and an atmosphere of safe enjoyment for the thousands of users.

As mentioned before, president of the Association is John Fagan from Breton Versatrek Ltd., vice-president is Hans Frank, Ontario Drive & Gear Ltd., secretary is Stewart Kinsman, ATV Manufacturing Ltd. Directors are: Brian Barr, Otaco Mfg. Ltd., Ron Beehoo, Beehoo Industries Ltd., Wes Cadman, Trackless Vehicles Ltd., Paul Durish, McKee Bros. Ltd., Joe Wappler, Multimobile Corp. Ltd., and Mike Friedrichs, Wheelermobile Ltd.

The ATV Story

by ROD MCTAGGART

TRACKLESS VEHICLES LTD.
BOX 100,
COURTLAND, ONT.

Trackless Vehicles Ltd., makers of the LOBO all-terrain vehicle, was formed in March 1969. Owner-president Wes Cadman founded the company to realize an idea he had for a heavy-duty all-purpose utility vehicle. The result: LOBO, a four-wheel ATV differing radically from most other ATV's in that it is in two segments, articulated in the centre and steered by a conventional steering wheel.

"I had been in the farm, lawn & garden and industrial equipment business for 18 years, building, selling and distributing all kinds of machinery," Cadman said recently. "I decided there was a need for a municipal sidewalk snow-clearing vehicle, with lots of traction but rubber-tired. LOBO was the result of much research of utility vehicles, and ATV's. But it goes much farther than sidewalk clearing. It's in a class by itself, because it was designed not as a sports vehicle, but a more rugged, more expensive off-the-road cargo-carrying utility vehicle. With its all-mechanical drive using many automotive parts, rather than the conventional ATV chain-sprocket drive, it carries eight people or two people and a 1200 lb payload."

Trackless employs six people, and covers about 15,000 sq. ft. of space in four buildings. "We have room to grow, and are looking for distributors and dealers in the Maritimes and Quebec. We're now established in western Canada, northern Ontario and Michigan," Cadman said.

ATV MANUFACTURING LTD.
5200 DIXIE RD.,
MISSISSAUGA, ONT.

ATV Mfg. Ltd. was formed specifically to market the Skipper ATV, which is made by an associated company in Tillsonburg, Ont.

Technical development of the Skipper took one year and was carried out by a group of mechanics, technicians and draftsmen under direction of a professional engineer. Market testing followed for six months in Canada and the USA.

Skipper is recognized as a sporty machine, with models ranging from 12.5 h.p. single cylinder to 24.5 h.p. two-cylinder engines. The first Skipper was a 20 h.p. model with electric start, dual headlights and tailights, reversing transmission and fuel gauge as standard equipment. Seating allows a family of five — two adults and three small kids — to ride in safety. A patented front jump seat keeps the youngsters in view of the driver.

Quality as well as features as considered, and Skipper has been built as a result on a structural aluminum frame, with one-inch solid steel axles, induction-hardened sprockets and gears and a lower, wider silhouette for better stability.

Skipper has recently become involved in racing, in Canada and the USA. In five events it has amassed 30 trophies, over half representing

(Continued on page 27)

Multimobile (left) has no gear-box or clutch. Drive to all six wheels is by chains with spring-loaded idler tensioners requiring no adjustment.

Expecting quite an increase in sales for their Argo ATV, first introduced in 1968, Ontario Drive and Gear hopes to hit 5,000-units sales in 1970

first place wins. Racing is considered by ATV's management team as an integral development tool, as it tests components under severe conditions. All Skipper racing vehicles use standard parts with nothing but the engine modified.

ATV Manufacturing Ltd., management is comprised of W.M. Nobbs, president, Stewart H. Kinsman, marketing manager, and John S. Gray, controller.

ONTARIO DRIVE AND GEAR LTD.
589 FAIRWAY RD.,
KITCHENER, ONT.

The Argo ATV was first made in 1968, following successful use of ODG's gear-type transmission in another ATV. Argo, however, was designed around a heavier, three-gear differential type transmission of the company's own design.

ODG, founded in 1963, had been making gears, transmissions and machine parts, for various industries. Now, with the successful introduction of the Argo ATV, it has expanded into a 37,000 sq. ft. plant, where the company has installed the largest fully automatic ABS-Cycolac vacuum moulding machine in North America, for the manufacture of the Argo bodies. They are made from 5/16" ABS sheet, and are turned out at the rate of three an hour.

Although production is limited currently to 15 Argos per day, the company is equipped to step up to 50 units daily should the market demand it. ODG hopes to hit 5,000-units sales in 1970, a reasonable sales goal, it is felt. This, compared with the first year's production of 300, is a sizeable increase. When put alongside ATV-market forecasts of 375,000 ATV's over the period 1969-74 ODG will likely be pushing close to its 50-per-day maximum before that period is over.

ODG markets the Argo throughout North America, and has established contacts in Europe, South Africa, and Central- and South America

BRETON VERSATREK LTD.
ORENDA RD.,
BRAMPTON, ONT.

The Jiger was the original ATV, and now the Jiger Twin-Six, a redesigned ATV resembling the first one in name only is made by Breton Versatrek Ltd., a company financed by the Cape Breton Development Corp. The Jiger name was purchased by Breton in 1968.

A 12.5 hp 2-cycle Hirth engine drives two Marshallmatic hydrostatic transmissions, and is steered by a T-bar utilizing the infinite drive ratios of the transmissions, one on each side. Body is moulded fibreglass, as is the front foot tray and back shelf.

The Jiger Twin Six is capable of speeds up to 40 mph, but is primarily a utility vehicle, lots of fun but not specially built for racing or speed sports. Breton intends the Jiger for use by logging, construction or Hydro workers in tough off-the-road locations, for hunters and fisherman, or for family fun. Because of the hydrostatic drive-steering, (it's the only ATV using this type of transmission proven successful on garden tractors and other utility vehicles) the Jiger can show amazing maneuverability, and can literally spin around in its own

(Continued on page 28)

(left to right): John Fagan, marketing manager and president of the ATV Association, Blair Mintz, service supervisor and Rob Fell, Ontario sales manager, Breton Verstarek, all seem quite excited about their new Jiger Twin-Six.

(Continued)

length like a top.

Dealerships across Canada carry the Jiger. (*pronounced jigger)* and are drawn from all types of small-engine, lawn & garden, snowmobile and automotive dealerships.

BEEHOO INDUSTRIES LTD.
OLD STATION RD., STREETSVILLE, ONT.

When Ron Beehoo jumped into the ATV business in the early 1960's, the second manufacturer to do so, he was interested in serving the same industrial market for which he'd been making special machinery for years.

His first ATV, a "mechanized aluminum box" proved to be so much fun that rubber tires, fibreglass bodies and more horsepower just had to happen, not just for better off-the-roadability, but because ATV's opened up a whole new world of family fun.

Making the bodies had been a bottle-neck — two or three a day were tops — when a Detroit plastics research firm offered to try their hand at it. The researchers — a division of Borg-Warner — started cranking them out and overnight the Amphicat was born in volume. Nine-thousand orders poured in from all over the USA and Canada. Since then, Ron Beehoo has granted a license to Magna American Corp. for manufacturing the Amphicat in the USA, and markets have opened up in 73 countries.

A recent addition to the ATV industry, the Roughrider is marketed in both the U.S. and Canada with a reported 75% of sales going to the States.

Customers for Amphicat have ranged all the way from a turtle rancher on Grand Cayman Island to the Banana Splits cartoon tv characters to John and Yoko Lennon, peace people and former Beatle. Sales volume for Amphicat are reportedly higher than all other Canadian ATV's combined, mostly because they've been on the market much longer.

Amphicat is available in 12.5, 16 and 20 h.p., all rated at 40 mph but with different load capabilities. Drive is by chain, and steering by twin-mounted handles.

MULTIMOBILE CORPORATION, 3094 LENWORTH DR., MISSISSAUGA, ONT.

The first time Joe Wappler, owner-president of Multimobile, got a look at an ATV, he knew he was looking at a big future market.

Owner of Canadian Steelmaster, makers of booms for trucks, Wappler spent several years testing, changing and simplifying ATV drive designs until he settled on a unique friction drive unit, no transmissions or clutches.

In 1968 production began, under the new company name. The Multimobile by 1970 is sold in major Canadian centres and in parts of the USA.

It is probably the simplest of all ATV's, because there is no gear-box or clutch. Drive to all six wheels is by chains, with spring-loaded idler tensioners requiring no adjustment. A variable-speed drive provides automatic shiftless ratio change with a built-in torque sensing unit.

The most outstanding feature is a patented single control lever for positive one-hand control. Called the joystick, one simply pushes it forward for acceleration, steers by moving it in the desired direction, brake by pulling back, and simply let go to brake on compression. It's a "deadman" throttle.

It comes with a 14 hp J.L.O. engine, which will run the Multimobile up 45 degree slopes, or achieve 35 mph. A special tuned muffler available increases it to 16 hp.

MCKEE BROS. LTD., ELMIRA, ONT.

The McKee Roughrider is a recent addition to the ATV industry,

(Continued on page 29)

Otaco Ltd.'s Bazoo is powered by an electric start 12.5 hp. or optional 18.5 hp. engine. Top speed with the smaller engine is just over 30 mph. Comfortable feature is three-inch foam seats plus extra-high seat back with two-inch foam padding.

The LOBO from Trackless Vehicles is a four-wheel ATV, with a said radical difference — it's in two segments, articulated in the centre and steered by a conventional steering wheel. Carries eight people or two people and a 1200 lb. payload.

ATV
(Continued)

and has rapidly established itself as a popular machine.

McKee Bros. Ltd., a wholly-owned subsidiary of Durish Investments, Toronto, has for 22 years built farm equipment and snowblowers. This spring the company announced it would move all the equipment manufacturing to a new 42,000 sq. ft. plant, leaving the current 31,000 sq. ft. exclusively for making of the Roughrider.

The Roughrider is marketed in Canada and the USA, with a reported 75% of sales going to the States.

Roughrider has a 14 hp. JLO engine, and drive is through a Salisbury torque converter and belt, through chains to the six wheels. It will reach 30 mph, turn in left and is steered by a unique system of two dash-mounted handlebars. It comes with electric start, and twin headlights.

ATV Mfg.'s Skipper took one year to develop. The result: a quality ATV.

OTACO LTD., DIV. BARTACO INDUSTRIES LTD., ORILLIA, ONT.

Otaco Ltd., the largest of the Bartaco Group of Companies, entered the ATV race in 1969 with production of the Bazooo. (Three zeros is correct).

Otaco produces a line of small agricultural implements, wheels, hubs, and axles for the trailer vehicle market, and a busy foundry operation. Last year Otaco added a Leisure Time Division under which several products are being manufactured or considered, including the Bazooo.

The Bazooo is powered by an electric start 12.5 hp engine, or optional 19.5 hp engine, and drive is by a Salisbury automatic torque converter, through a transmission. Top speed with the smaller engine is just over 30 mph. The body is four-ply fibreglass, bolted to a welded unibody chassis. Nice feature is three-inch foam seats, and an extra-high seat back with two-inch foam padding.

Rod McTaggart, our Toronto editor, recently got taken for a ride-in an ATV. Here in his own words he describes personal cowardice and how it feels to go ATV-ing.

Unless you've actually conquered the wilderness in an ATV — whether you're six or 60, man, woman, child or beast — you really don't know what fun can be.

All the pictures in the world, even movies of ATV's in action, can't possibly communicate the fantastic, almost unbelievability of leaping and bounding across everything in your path, wet or dry.

ATV means all-terrain vehicle, and the folks who dreamed up the name weren't kidding. When we went for our first ride recently in an ATV, "all-terrain" was some foggy concept in our minds about Mother Nature — fields, streams, lakes, snow, rocks, sand, mud, swamp, hills, valleys, highways, forests — that's "all-terrain". Tack on the word "vehicle", get in one, and all of a sudden you find out why these wild, little machines got the name. Here's our experience as a passenger, first ride:

Zoom! Bounce! Jog! Wham! over a three-foot log and we were off at something near 1,000 miles per hour through dense under-brush, and it was hang-on-and-whoop time for this jaded writer who thought he'd done it all. Blam! and you burst out of the brush into sunshine gleaming from a . . . oh, oh, look out it's a river! Zip . . . Rmmmmmm Splash! When the heart gets out of the throat and back where it belongs, and the breathing returns to normal, you wipe the silly grin from your face (remember, you're a Grown Man) and peace, serenity and something describable only as a feeling of freedom takes over, as this crazy little car floats lazily along a stream, the bullrushes pass by, the red-wing blackbirds scoot away through reeds.

This is Living, Man! But don't relax too much, the driver (who we know is very experienced) has lost his mind. He's heading straight for a rapids, with at least a four-foot drop to white water. So much for peace. Lookout, a log! Thump, so much for the log. Why didn't we sink? Rapids, lookout for the rapids! Swish! So much for the rapids. Hmmmmm. Not bad. Relax, kid, and wipe off that silly grin!

Now what. He has definitely lost his mind. Trying to impress the journalist, he's giving this insane little vehicle more than it can possibly handle. Heading straight for the bank to get out of the river, but can't he see it's a vertical bank two feet high? This is it. Glad my insurance is paid up. Rmmmmm. We're over the bank on dry land. How did that happen? Relief. Look at the driver, and he's actually sort of bored.

There is now a rock, slightly smaller than Gibraltar, which one could easily detour. Why does he want to kill us all and go over? Over we go. Fantastic. We begin really to appreciate this ATV stuff; the driver now has a mad grin on his face, too, except his looks intelligent. Mine is just silly.

The whole thing finishes with our feeling like we've just won World War III, have now really done it all, we're veterans, you see. And we have a determinism to own an ATV some day if we have to hock the wife and kids to get it. Not so we can farm, fish, hunt, build, mine, log or put up hydro lines better like some folks. Just to get that grin pasted on again.

Just for the crazy fun of it.

If you can't sink ...you can't get stuck

ROLLSPORT

Here's why: it stays on top... not in!

From desert to tundra —with true steering under power

The most versatile of amphibious machines in existence. Outperforms Hovercrafts, ATV's, Snowmobiles, four wheel drives & track machines.

An all-season—all-purpose ATV

ROLLSPORT

Rollsport Ltd.,

411 Dudley St. North Bay, Ontario
Tel: (705) 472-8237

Circle Reply Card #3

DID YOU EVER GET RUN OVER JUST FOR THE FUN OF IT?

by John S. Coppinger

It wasn't just an accidental case of hit and run — I asked him to run over me! No suicidal intent either. It was simply that if this wondrous machine would run over everything else it could certainly run over me. So it did. All eight wheels of it. And all it felt like was my girlfriend sitting on me. She has almost as much rubber on her as this baby, and she's just as tender.

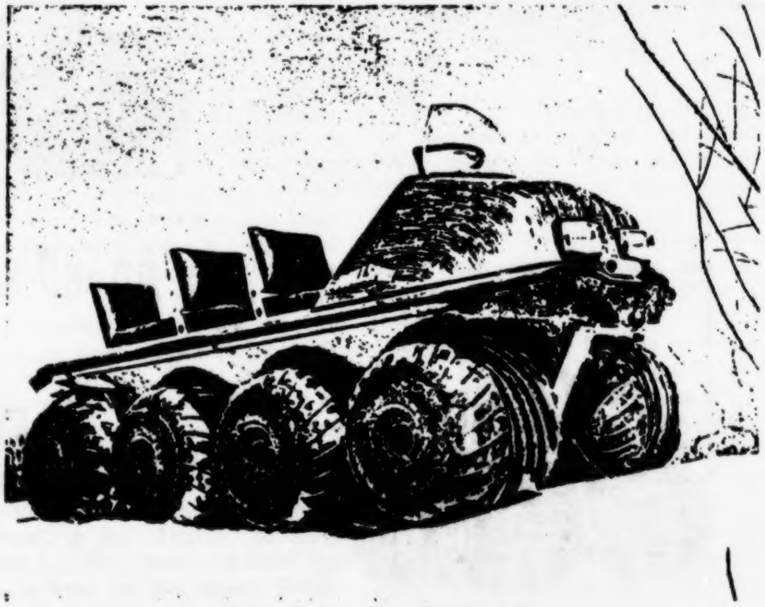
We Canadians are justifiably proud of our inventions. We gave the world the safety pin, Standard Time, the telephone, the snowmobile and now — the Rollsport.

The Rollsport is the first truly all-season, all-terrain vehicle designed for both recreational and industrial use. It is the product of the creative genius of Cedric Summers of North Bay, Ontario. Mr. Summers is no man inventor. A few years ago he invented the famous Sportspal canoe. You know the one — untippable, unsinkable, weighed 29½ pounds, and you could put an outboard motor on it! Well, Cedric has done it again!

At our request, his son Eric brought the machine down from North Bay and gave us a demonstration of its amazing versatility. We had made arrangements with the Montreal Parks Department to use Ile Ste. Helene, one of the three Expo islands, as our test ground.

Out of the van came the Rollsport and up over the island it went — up the old battlement steps, up steep grassy knolls, through the lily ponds. Backwards, forwards, over rocks, logs, and me. Of course, one of its principal features is that it doesn't damage the terrain. Hell, if it couldn't bruise this 98 pound weakling you can imagine how gentle it is on Canada's tender ecology.

The massive flotation of the eight specially designed tires; plus a revolutionary principle of continuous power with steering; plus a narrow 4 inch center means it stays not in, but on water, mud, snow, slush, muskeg,



quicksand, etc., making it virtually impossible to mire or hang up at any time in any type of terrain. It weighs just under 500 pounds but it can pull ten times its own weight. Its recreational and industrial possibilities are limitless. Eric Summers even sees it eventually replacing the snowmobile, not to mention all other types of A.T.V.'s.

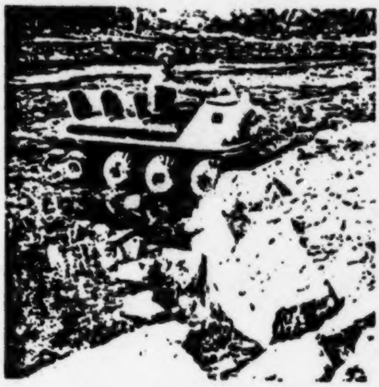
Interested investors are advised to call C.R. Summers, Rollsport Ltd., 411 Dudley St., North Bay, Ontario.

Cedric Summers is a most interesting character, a la Thomas Alva Edison. He, like all inventors, has his idiosyncrasies. He must be the only cigar-chomping guy in the north who drives a birch-back finished, front wheel drive Cadillac Eldorado. The man is not the type to get all dressed up for work and wears a checked shirt and a pair of unlaced Kodiak boots. To a question about how good present ATV's were, he replied: "I bet they haven't spent less than $50 million on them and they haven't built one yet that will do the job."

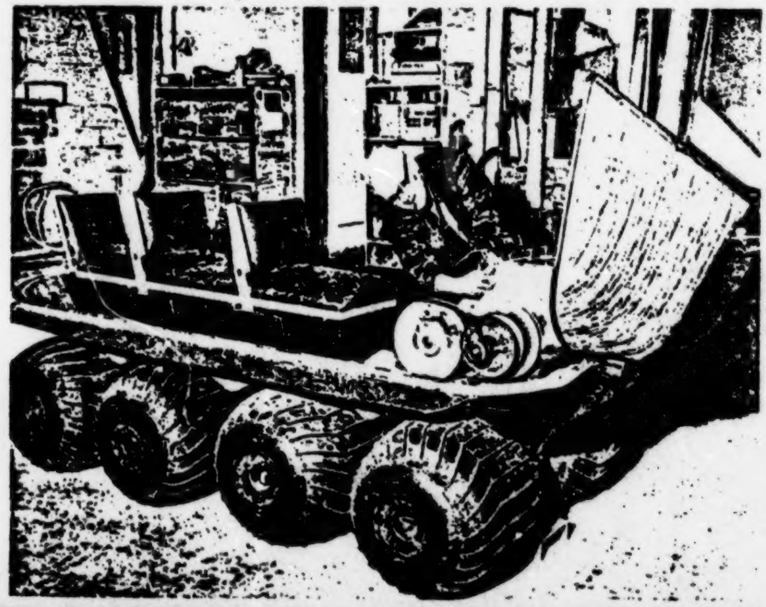
In a recent story about this clever innovator, one journalist quoted Mr. Summers: "I hunt and fish all year round and in the past there wasn't one machine that would run on land, water and snow. I know, because I've owned a half a dozen different kinds. I couldn't buy one, so I decided to build one."

Having time on his hands after relinquishing his holdings in the now famous "Sportspal" canoes, Cedric Summers turned his inventive genius to the problem of building an all-season, all-purpose vehicle. "I started thinking about it and analysing what was wrong with the machines I had owned. It boiled down to one basic concept; they couldn't operate under all conditions, all year round."

Mr. Summers had discovered many years ago that the basic principle behind any vehicle was, "you must have more traction than drag at all times under all and any conditions." Our Canadian Sno-Mobile's staff can vouch for that! We have seen other ATV's get mired and have to pulled out, but the Rollsport just wouldn't cooperate. It refused to get stuck in anything! Which brings us back to Cedric's cryptic quote: "If it won't sink, it can't get stuck." It is a brilliant principle. Why no one thought of it before, we don't really know. But, Mr. Summers has that kind of original mind, seen only a few times a century, which transcends such simple problems. He not only dreamt of the kind of machine that would perform in all conditions. "The worst conditions we have to contend with are deep snow, muskeg, slush and mud — if you sink into one of them and they make contact with any non-driving parts of your vehicle, you create friction or drag and become mired" — he built one to overcome all those problems.



Apparently, the whole trick is to stay on top of these terrestrial conditions and not in them. And, this is what Cedric Summers and his son, Eric, have done with the Rollsport. The eight huge, specially designed tires, combined with the machines' low weight and extremely low centre of gravity completely separate the chassis of the vehicle from the surface of any part of our Earth, be it dry, rocky or water-bound.



Mr. Summers has been obsessed with the idea of this 'super' machine since 1951. After five prototypes he has developed the machine that answers his basic requirements to do the job. "The potential is certainly there to revolutionize the over-land vehicle industry," said his son, Eric. "We have just finished our initial production run and the qualitative results have been beyond our expectations."

As the editor, I can say without equivocation this machine has all the earmarks of the overland, all-season, all-purpose vehicle of the near future. If any of you investors out there are listening, you'd better get in on the ground floor, because this baby, the Rollsport, is going to make the snowmobile look sick.